COST-BENEFIT ASSESSMENT

OF IMPLEMENTING LULUCF ACCOUNTING RULES IN TURKEY

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Summary

This Report (14-06-05 Cost-Benefit Assessment of LULUCF in Turkey.docx) shall be read in conjunction with its attached Spreadsheets (14-06-05 Cost-Benefit Assessment of LULUCF in Turkey.xlsx).

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Acronyms

AAU	Assigned Amount Unit
ACL	Annual Cropland
ADP	Ad Hoc Working Group on the Durban Platform for Enhanced Action
AFOLU	Agriculture, Forestry, and Other Land Use
AGB	Above-Ground Biomass
AGM	GD for Reforestation and Erosion Control
AOSIS	Alliance of Small Island States
AR	Afforestation/Reforestation
AWG-KP	Ad Hoc Working Group on Further Commitments for Annex 1 Parties under the KP
AWG-LCA	Ad Hoc Working Group on Long Term Cooperative Action under the Convention
BASIC	Brazil, South Africa, India, and China
BaU	Business as Usual
BCEF	Biomass Conversion and Expansion Factor
BEF	Biomass Expansion Factor
BGB	Below-Ground Biomass
C	Carbon (C = 12/44 CO2)
CBCC	Coordination Board on Climate Change
CBDR	Common But Differentiated Responsibilities
CDM	Clean Development Mechanism
CF	Carbon Fraction
CM	Cropland Management
CMP	Conference of the Parties serving as the meeting of the Parties to the KP
COP	Conference of the Parties
CRF	Common Reporting Format
D	Basic Wood Density
DIE	State Statistical Institute
DOM	Dead Organic Matter
ENVANIS	Forest Inventory and Statistical Database
Erat	Emission Ratio
ERT	Expert Review Team
EU	European Union
FAO	Food and Agriculture Organisation
Fbl	Fraction of biomass left as dead wood
FL	Forest Land
FM	Forest Management
FRA	Forest Resource Assessment
GD	General Directorates
GEF	Global Environment Fund
GgC	Gigagram of Carbon (1 GgC = 1 ktC)
GHG	Greenhouse Gas
GIS	Geographical Information System
GM	Grassland Management
GNP	Gross National Product
GS	Growing Stock
Ha	Hectare
HL	Half Life
HWP	Harvested Wood Product
IEA	International Energy Agency
IEF	Implied Emission Factor
IPCC	Intergovernmental Panel of experts on Climate Change
Iv	Volume Increment
JI	Joint Implementation

K	Decay constant of first order decay
KP	Kyoto Protocol
LB	Living Biomass
LDC	Least Developed Country
LULUCF	Land Use, Land Use Change, and Forestry
MFAL	Ministry of Foo, Agriculture, and Livestock
MFWW	Ministry of Forest and Water Works
Mha	Million of ha
MP	GD for National Parks and Game-Wildlife, MFWW
MRV	Monitoring, Reporting, and Verification
MW	MegaWatt
NAMA	Nationally Appropriate Mitigation Action
NC	National Communication
NCCAP	National Climate Change Action Plan
NFI	National Forest Inventory
NFP	National Forest Programme
NGO	Non-Governmental Organisation
NIR	National Inventory Report
NWFP	Non Wood Forest Product
OECD	Organisation for Economic Cooperation and Development
OGM	GD for Forestry, MFWW
ORKÖY	GD for Forest Village Relations, MFWW
OWL	Other Wooded Land
PCL	Permanent Cropland
Ppm	Part per million
QA/QC	Quality Assessment/Quality Control
R	Root-to-shoot ratio
REDD+	Reducing GHG emissions from Deforestation and Forest Degradation, and maintaining or increasing forest carbon stocks
REL	Reference Emission Level
RMU	Removal Unit
R-PP	Readiness Preparation proposal
RV	Revegetation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SOC	Soil Organic Carbon
TARBIL	Agriculture Database System
TARSIM	Agricultural Parcel Information System
tCO2eq	Ton of Carbon Dioxide Equivalent
Tdm	Ton of dry matter
TEV	Total Economic Value
TOE	Ton of Oil Equivalent
TL	Turkish Lira (2.176 TL/US$ as of February 2014)
TUBITAK	Scientific and Technical Research Commission of Turkey
TurkStat	Turkish Statistical Institute
UNDP	United Nations Development Programme
UNECE	United Nation Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forest
US$	United States Dollar
USA	United States of America
VOB	Volume Over Bark
VUB	Volume Under Bark
WDR	Wetland Drainage and Rewetting

Summary for policy-makers

Part 1 ➔ Turkey in the current/future climate regime, incl. LULUCF

Turkey is an Annex 1 Party with “specific circumstances”: because of its fastest population growth rate among all OECD countries and its lowest energy related CO2 emissions per capita among IEA countries. National indicators could lead to consider Turkey as a developing country. In that context, the name of Turkey was deleted from the Annex 2 of the UNFCCC and Turkey was not included in the Annex B of the KP1.

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 it seems useful to explore the possible consequences of such reclassification.

Based on the foregoing, the present study aims at providing for a neutral costs and benefits assessment of implementing LULUCF accounting rules in Turkey in the future, as one possibility among other. The rationale for this assessment is based on a technical and objective deduction and does not, in any way, pre-empt the national positions put forward by Turkey in the climate negotiations, nor any possible COP Decision that may precise its future classification, taking into account its specific circumstances.

Part 2 ➔ Upgraded LULUCF accounting rules to be considered

Since the start of the Kyoto Protocol, the forest sector has been more prominent in the LULUCF accounting rules than the agriculture sector (NB: carbon stock changes in agriculture soils considered under the “LULUCF” part of the greenhouse inventory, while CH4 and N2O emissions are considered under the “Agriculture” part). It presents great mitigation potentials: avoided deforestation and degradation, sustainable forest management, afforestation/reforestation, substitution of fossil fuel, carbon storage in wood products, and substitution of “grey energy” in building and housing materials…

However, this mitigation potential was poorly realised till now, due to technical constraints related to the specific nature of LULUCF: high inter/intra-annual variability of forest growth and loss, vulnerability and non-permanence of forest carbon, non additionnality of a certain part of the carbon sequestration.

There were also some political concerns at the time the Kyoto Protocol was designed: lack of scientific knowledge and consensus on forest sinks, fear of dilution of efforts, inverted agenda between the creation of the LULUCF (in Kyoto, 1997) and the setting of the precise LULUCF accounting rules (in Marrakech, 2001).

The initial LULUCF accounting rules – in use for the first commitment period, from 2008 to 2012 - were set in the Articles 3.3 and 3.4 of the Kyoto Protocol, and further detailed in the Marrakech Accords in 2001. These LULUCF accounting rules were upgraded in the recent climate talks (Cancun in 2010, Durban in 2011, and Doha in 2012) and will be used by Annex 1 Parties with binding commitments for the second commitment period, from 2013 to 2020.

The main features of these upgraded rules are as follow: (i) accounting for afforestation/reforestation and deforestation under Art. 3.3 is still mandatory (and “gross-net”), (ii) accounting for forest management under Art. 3.4 is now mandatory (and “net-net” with cap of 3.5% of the 1990 total greenhouse gas emissions excluding LULUCF), (iii) accounting for cropland management, grassland management, revegetation under Art. 3.4 is still voluntary (and “net-net”), (iv) a new activity appears under Art. 3.4: wetland drainage and rewetting (voluntary and “net-net”).

For the specific case of Art. 3.4 forest management: accounting for carbon storage in harvested wood products is now possible; emissions due to natural disturbances can be discounted, following specific guidelines.

The accounting of forest greenhouse gases emissions and removals under the Kyoto Protocol are based on the same reporting requirements as under the Climate Convention: (i) estimating activity data and emissions factor for different carbon pools (living biomass, dead organic matter, soil organic carbon), (ii) respecting the principles of transparency, accuracy, precision, completeness, comparability, and consistency, (iii) using adequate Tier and Approaches, according to a Key category analysis. However, LULUCF accounting presents specific challenges, especially related to the tracking of land use changes according to the activities defined in Articles 3.3 and 3.4 of the Kyoto Protocol.

Part 3 ➔ State of LULUCF in Turkey and key changes foreseen by 2020

Within the Ministry of Forest and Water Works (MFWW), the General Directorate for Forestry (OGM) is the main responsible for the management of forest. According to the national definition, there is around 21.7 Mha of forest (27% of Turkey), 53% considered “productive” (above 10% of forest cover) and 43% considered “degraded” (between 1% and 10% of forest cover).

There are several concerns about the identification of “forest land” in the LULUCF reporting for the Climate Convention: Inclusion (or not) of “unmanaged forest”? Coherence between “legal boundary” (cadastre) and “technical boundary” (management plan)? Consideration of private afforestation? But, first and foremost, there is a concern about the use of the national definition, which is not in line with the FAO definition, and consequently, with a potential definition of forest under the Kyoto Protocol.

The study therefore uses the FAO definition to identify and triangulate historical data series related to the forest area, including afforestation/reforestation, the biomass stock and volume increment, the harvest (felling and firewood), the forest fires, other biotic (insects, pests, diseases) and abiotic (storms, avalanches, flooding, etc.) damages.

Overall, an impressive improvement of the Turkish forests 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 felling since the 2000’s.

Turkey started reporting LULUCF under the Climate Convention in 2006. Presently, the LULUCF sink (made of the forest sink for its bigger part) is estimated to offset 12% of the total greenhouse emissions of Turkey.

However, this figure is to be considered cautiously, since weaknesses and shortcomings were identified in the last LULUCF inventories: absence of a key category analysis, use of low Tier for certain categories suspected to be keys, inconsistency between the land use representation for forest (based on the ENVANIS database,) and other land uses (based on Corine Land Cover), lack of a coherent quality analysis/ control system, lack of transparency for certain data or assumptions, etc.

Based on that, it was considered preferable to compile all the historical activity data series available and to project these activity data up to 2020, based on the foreseen changes in the LULUCF sector in Turkey (afforestation, harvest, forest fire fighting, etc.). In parallel, the emission factors and key dendrometric variables (stocks per forest type, volume increments, basic wood densities, biomass expansion factors, etc.) were reviewed.

For afforestation/reforestation (Article 3.3.), the objectives of the 2014-2017 OGM Strategic Plan were considered. For forest management (Article 3.4), two alternative scenarios were considered: 90Mm3 of roundwood harvest between 2013 and 2017 (intensive harvest) and 25 Mm3/yr of felling (industrial roundwood) harvest by 2020 (extensive harvest). The corresponding volumes of firewood, felling and total roundwood were forecasted accordingly from 2013 to 2020.

In terms of biotic and abiotic damages, a specific focus was put on forest fire and the associated biomass losses were forecasted from 2013 to 2020. The decrease of biomass loss and the increase of biomass loss associated with the other damages were assumed to be already captured in the ENVANIS database and the Wood Marketing database.

Part 4 ➔ Recap of carbon and non-carbon costs and benefits and key findings

Cost-benefit estimates are expressed in monetary terms, i.e. USD, not implying that the international community should necessarily reward Turkey, but rather because it is the easiest way for valuing very diverse direct and indirect, tradable and non-tradable, costs and benefits.

The carbon credits, or Removal Units (RMUs), for Art. 3.3 ARD and Art. 3.4 FM (including the carbon storage in harvested wood products) were estimated using the guidelines from the Intergovernmental Panel of experts on Climate Change, and taking into account the upgraded LULUCF rules.

For Art. 3.4 FM, it depends on different manners to set the Reference Emissions Levels (RELs):

All numbers in MtCO2eq	Number of	Corresponding	Difference if		Removal Units	
Choice of REL	**Annex 1 Parties**	**REL in Turkey**	**Int. Scen.**	**Ext. Scen.**	**Int. Scen.**	**Ext. Scen.**
2020 projections	31 (incl. 24 EU States)	-235,7	0,0	-46,5	-	46,5
Historical 1990	3 (Belarus, Norway, Russia)	-157,0	-78,7	-125,2	52,8	52,8
Average 1990-2009	1 Greece	-176,2	-59,5	-106,0	52,8	52,8
Linear trend 1900-2008	2 (Cyprus and Malta)	na (no linear trend)			-	-
0	1 (Japan)	0	-235,7	-282,2	52,8	52,8
1990 GHG emissions in Turkey excl. LULUCF (tCO2eq/yr)		188,4		Cap of 3.5%	-52,8	

Figure 54 - Five different RELs for Art. 3.4 FM in Turkey and numerical consequences (BOUYER, 2014)

For Art. 3.3, it was estimated that 119.4 million of RMUs could be generated between 2013 and 2020, which is more than two times the maximum amount of RMUs to be generated under Art. 3.4 FM.

The operation and transaction costs associated with Art. 3.3 and Art. 3.4 were then estimated:

- For Art. 3.4, the operation cost is equal to the cost of forest management, which converts into 14.6 US$/RMU. If the REL is projected, then an additional 52.1 US$/RMU of opportunity cost for reduced felling has to be added, thus amounting to 66.7 US$/RMU;
- For Art. 3.3, the operation cost is made of plantation cost (for year 1 to 4) and forest management cost (from year 5 onward) and amounts up to 86.4 US$/RMU.
- For Art. 3.3 and Art. 3.4, the transaction cost is mainly made of upgrading of the current LULUCF inventory. It is assumed to be marginal, around 1.2 MUS$ (expert judgment) in total as most of the data sources are already available and the main efforts to be done would be in terms of human resources. The transaction cost would therefore range from 0.01 to 0.007 US$/RMU.

Last but not the least, the different non-carbon values (wood and non-wood products, grazing, hunting, recreation, pharmaceuticals use) and costs (erosion, forest fires) forming the Total Economic Value (TEV) of the Turkish forests were reviewed: the revised TEV is estimated at 142 US$/ha/yr.

Based on the above, a complete assessment of carbon and non-carbon costs and benefits of implementing the LULUCF rules was carried out, for four different 3.4 FM scenarios (extensive vs intensive harvest, projected vs non-projected REL) and one single 3.3 AR scenario:

Scenario for 3.4 FM, depending on the level of harvest by 2020 (in Mm3/yr)	REL non projected*		REL projected	
	Ext. harvest	Int. harvest	Ext. harvest	Int. harvest
	32,3	36,3	32,3	36,3
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int
Scenario for 3.3. ARD: 2013-2017 OGM Strategic Plan, followed by linear trend from 2018 to 2020				
Cumulative area under 3.4 FM (ha, over 2013-2020)	77 145 301			
Non-C benefit for 3.4 FM (MUS$)	**10 968**			
Cumulative gain of forest under 3.3 ARD (ha, over 2013-2020)	19 046 995			
Non C-benefit of 3.3 AR (MUS$)	**2 708**			
3.4 FM RMUs between 2013-2020 (Million of RMUs)	52,8	52,8	46,5	0
C benefit for 3.4 FM (MUS$)	**264**	**264**	**232**	**0**
3.3 ARD RMUs between 2013-2020 (Million of RMUs)	119,4			
C benefit for 3.3 ARD (MUS$)	**597**			
Operation costs for 3.4 FM: forest management (MUS$)	**771**			
Operation costs for 3.3 ARD: AR and forest management (MUS$)	**3 221**			
Transaction costs for GHG LULUCF inventory (MUS$)	**1**			
TOTAL	**7 835**	**7 835**	**7 804**	**7 571**
** historical level 1990, or average 1990-2010 or 0 (see detailed data in* ***Excel sheet CCL 3.4****)*				

Figure 66 - Recap of costs and benefits estimates of LULUCF accounting for different scenario (BOUYER, 2014)

All the costs are assumed to be constant, whatever the scenario. The sensibility of the estimated benefits to different carbon price assumption was carried out:

- 4 US$/tCO2eq. This is the lowest values observed in 2013 on the European carbon market, the bigger Kyoto market worldwide;
- 7 US$/tCO2eq. In 2013, the average forest carbon price, on both Kyoto market and voluntary markets was 7 US$, according to the Ecosystem Marketplace report from 2013;

- 52 US$/tCO2eq. Commissioned by the French Prime Minister in 2008, a report estimated the “shadow price” of carbon, i.e. the recommended carbon price from 2011 up to 2050, to achieve the EU target of diving GHG emissions by four by 2050 (QUINET, 2009). The estimated value (by linear interpolation) for 2013 is 52 US$/tCO2eq

if RMU price (US$)	***4***	**2013 EU C market price**				
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int		
Non-C benefit 3.4	98%	98%	98%	100%	Non-C benefit 3.3	85%
C benefit 3.4	**2%**	**2%**	**2%**	**0%**	C benefit 3.3	**15%**
Total benefit 3.4	100%	100%	100%	100%	Total benefit 3.3	100%
if RMU price (US$)	***7***	**2013 forest C price**				
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int		
Non-C benefit 3.4	97%	97%	97%	100%	Non-C benefit 3.3	76%
C benefit 3.4	**3%**	**3%**	**3%**	**0%**	C benefit 3.3	**24%**
Total benefit 3.4	100%	100%	100%	100%	Total benefit 3.3	100%
if RMU price (US$)	***52***	**2013 C shadow price**				
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int		
Non-C benefit 3.4	80%	80%	82%	100%	Non-C benefit 3.3	30%
C benefit 3.4	**20%**	**20%**	**18%**	**0%**	C benefit 3.3	**70%**
Total benefit 3.4	100%	100%	100%	100%	Total benefit 3.3	100%

Table 16 - Sensibility analysis of C vs non-C benefits with regard to C price (BOUYER, 2014)

As it can be observed, taking into account the recent EU Market price (Kyoto market) or the recent forest carbon price (Kyoto and voluntary markets), the carbon benefits are low in all the scenarios, compared to other values included in the TEV of forest.

However, since most of the operating costs would have been disbursed anyway (apart for the transaction cost for upgrading the GHG LULUCF inventory, but it is marginal: 1.2 MUS$), the carbon benefits can be assumed to be “extra net-benefits”. Furthermore, at the contrary to many forest values, the carbon benefits can materialise.

Last but not the least, if we consider the carbon shadow price, it is worth noting that the situation is quite different: for the 3.4 FM areas, and mainly for 3.3 ARD areas, the carbon benefits are substantial. However, this price level is still far from reach as the negotiations stand now…unless the international community is able to adopt a strong political commitment in the coming years.

1. International context: KP2 (2013-2020) & 2015 Accord (2020 onward)

1.1. Key debate: differentiation Annex 1 Parties vs Non-Annex 1 Parties

In order to understand the key issue at stake in the international climate negotiations, i.e. the differentiation "Annex 1 Parties" (developed countries listed in Annex 1 to the United Nations Framework Climate Change Convention - UNFCCC) vs "Non-Annex 1 Parties" (developing countries), it seems useful to present here below a short (and very simplified) summary of the outcomes of the last Conference of Parties (COP) to the UNFCCC:

➔ COP13 – Bali, 2007

In 2007, the Intergovernmental Panel of Experts on Climate Change (IPCC) published its fourth assessment report with the following key conclusions:

- To have a good chance of holding the increase in global temperature below +2°C, CO2 concentration has to be stabilised below 450 parts per million ppm, which implies that:
- Developed countries reduce their Greenhouse Gases (GHG) emissions by -25 % to -40 % by 2020 compared to 1990 levels, and from -80 % to -95% by 2050 compared to 1990 levels;
- Developing countries inflect their GHG emissions by -15% to -30 % by 2020 compared to their "Business as Usual" (BaU) trends of emissions.

Having these findings in mind, the international community adopted the Bali Action Plan in late 2007. This plan is based on two tracks:

- AWG-KP: Ad Hoc Working Group on Further Commitments for Annex 1 Parties under the Kyoto Protocol (KP). This AWG-KP was created at COP11, in Montreal, 2005.
- AWG-LCA: Ad Hoc Working Group on Long Term Cooperative Action under the Convention (i.e. for Annex 1 and Non Annex 1 Parties), based on the informal "Dialogue on long-term cooperation", also created at COP11.

The aim of the Bali Action Plan (See Decision 1/CP13) was to define a 2007-2009 roadmap to guide the negotiations under AWG-LCA and AWG-KP, and to adopt a post-2012 multilateral climate regime in 2009. 2009 was chosen in order to allow parliamentary ratifications between 2009 and 2012 and to have continuity with the first commitment period of the KP (which ended in late 2012).

➔ COP15 – Copenhagen, 2009

After two years of intense negotiations (but no real stocktaking Decisions at COP14 – Poznan, 2008) came the long-awaited conclusion of the work of the Bali Action Plan at the Copenhagen Climate Conference in late 2009...Unfortunately, it happened to be a failure! There was no multilateral treaty, but a little ambitious "Copenhagen Accord" gathering 28 countries.

After intense and controversial discussions, the COP finally took note of this Accord. Its only numerical target is "Limiting global temperature increase below +2°C". There is no binding target in terms of GHG emissions reductions and only an "aspirational" goal of channelling 30 billion US$ over 2010-2012 for developing countries, and 100 billion US$ per year by 2020.

The opposition between Annex 1 Parties and Non-Annex 1 Parties started at that time:

- The latter accusing the former of (i) not taking ambitious GHG emissions reduction commitments, despite of their historical responsibility in terms of climate change, (ii) not taking ambitious financial pledges in favour of developing countries, in respect of the principle of "Common But Differentiated Responsibility" (CBDR) stated in the UNFCCC;
- The former accusing the latter of not proposing ambitious GHG emissions inflections compared to their BaU trends of emissions, on a voluntary basis, highlighting the facts that some of them have a high growth rate and a level of GHG emissions per capita that make them closer from Annex 1 Parties than Non Annex 1 Parties.

Most of the Non-Annex 1 Parties started to complain against the lack of ambition and the non-respect of the principles of historical responsibility and CBDR by Annex 1 Parties, the most virulent being the BASIC, a coalition of major developing countries: Brazil, South Africa, India, and China.

➔ COP16 – Cancun, 2010

After claiming that there would be no "Plan B" in case of failure in Copenhagen, thus generating high expectations on the part of civil society and the media, the climate negotiators were forced to imagine a Plan B in 2010...Aware of the difficulty in keeping the process on track, the UNFCCC Secretariat explained before the COP16 that "Multilateralism should not be considered an endless road."

Against all odds and after spending days of debate about "how to debate," the goal was reached in Cancun: keep the process alive and avoid the endless road turns into a dead end. There was even some progress: resuming a Decision of the key elements of the Copenhagen Accord (+2°C, CBDR, funding of 30 billion US$ for 2010-2012 and 100 billion US$ per year by 2020), creation of a Register of Nationally Appropriate Mitigation Actions (NAMAs), a Green Climate Fund, an Adaptation Committee, a Climate Technology Centre, refining the REDD+ mechanism (Reducing GHG emissions from Deforestation and Forest Degradation, and maintaining or increasing forest carbon stocks), etc.

But this "progress" did not address the key issue at stake since Copenhagen: on which basis to decide which Parties have to reduce their GHG emissions and/or provide climate finance?

➔ COP17 – Durban, 2011

As we have seen, the Bali Action Plan created two negotiating tracks: AWG-LCA and AWG-KP. Ideally, the former was to create a new legally binding treaty, including all countries, developed or not, in which housing would have come an extension of the KP, created under the AWG-KP.

Both AWG had to stop in Copenhagen in 2009...but the failure of that Conference had brought the parties to extend them to Cancun (2010) and Durban (2011). The Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP), "Durban Platform" in short, was thought of as a third track to compensate for the stagnation of negotiations in the two existing AWG:

- Opposition of "emerging" developing countries to discuss about voluntary GHG emissions reduction pledges from their side under the AWG-LCA;
- Opposition of some developed countries to take ambitious post-2012 GHG emissions reduction commitments under the AWG -KP.

The purpose of this ADP was to facilitate and to accelerate the negotiations, in order to lead to a single multilateral climate treaty in 2015, which would come into force from 2020. The creation of the ADP was a step forward in addressing the key issue of the differentiation between Parties (in terms of GHG emissions reduction commitments and climate finance pledges), but the Durban talks did not touch upon the underlying issues: on which basis to do the differentiation?

➔ COP18 – Doha, 2012

COP15 in Copenhagen, 2009, was the great missed appointment...COP16 in Cancun, 2010, was about maintaining multilateral discussions alive...COP17 in Durban, 2011, saw the comeback of a cautious optimism lost in Copenhagen...COP18 in Doha, 2012, saw the end of an arduous cycle!:

- Closure of the AWG-KP launched seven years ago, at COP11 in Montreal in 2005;
- Closure of the AWG-LCA launched five years ago, at COP13 in Bali, 2007;
- Official launch of the Durban Platform (ADP) to arrive in 2015 to a post-2020 multilateral climate treaty with ALL countries.

All the foregoing was conditioned to the "Durban Deal", i.e. launch of the ADP and closure of the AWG-KP after adoption of a post-2012 amendment to the KP ("KP2": 2013-2020. See Decision 1/CMP.8). But, the "Doha Climate Gateway" was immediately criticised for two reasons:

- The account is not there! The United Stated of America (USA) still refused to ratify the KP. Canada, which ratified the KP, announced it would leave it. The Russian Federation, New Zealand, and Japan announced they would not ratify the KP2. Accordingly, the overall GHG emissions reduction commitment has reduced over 2013-2020 compared to 2008-2012:
  - o KP1 (2008-2012): 55% of global GHG emissions and -5.2% compared to 1990 = equivalent to -2.9% of all global GHG emissions compared to 1990;
  - o KP2 (2013-2020): 14% of global GHG emissions (four times less) and -18% compared to 1990 = equivalent to -2.5% of all global GHG emissions compared to 1990.

- Once again, like in Durban, the official launch of the ADP was a step forward, but more from a procedural point of view (creation of a third track of negotiations where the distinction between Annex 1 and Non-Annex 1 Parties can be revisited) than from a political point of view (no clear guidance on which basis to do the differentiation).

➔ COP19 – Warsaw, 2013

At the closing plenary, the Alliance of Small Island States (AOSIS) deplored "*the disastrous gap in terms of ambition*". The Least Developed Countries (LDCs) Group welcomed the establishment of the mechanism on loss and damage, but lamented the lack of progress on the provision of long-term finance, and called for an acceleration of negotiations under ADP. The African Group called on developed countries to ratify the Doha Amendment urgently and deplored their lack of ambition…

In short, political determination failed to COP19 ... Those who bet, before COP19, on a "financing COP" or an "implementation COP", finally saw a "REDD+ COP" (seven Decisions adopted on REDD+)...with limited progress on long-term finance (without numerical objectives or calendar or guidelines on Measuring, Reporting and Verification – MRV) and the "loss and damage" mechanism.

In conclusion, it is unlikely that ADP makes progress in 2014 if the "chicken and egg" blockage continues:

- As part of the post-2020 multilateral treaty, most of the developed countries absolutely wants to review the dichotomy between Annex 1 vs Non-Annex 1 Parties, this differentiation dating from 1990, while some developing countries such as China have per capita emissions levels similar to those of developed countries;
- As part of the KP amendment 2013-2020, developing countries called on developed countries to drastically raise their level of ambition: (i) few of them have commitments (only 15 % of global GHG emissions covered), (ii) commitments are well below what recommended IPCC to stay below +2°C.

More than ever, a surge of political will is required to enter the final straight for a post-2020 multilateral treaty. Tough debates are ahead of us and touch upon the key principles of the UNFCCC: historical responsibility, CBDR, equity, transparency, etc. It is now hoped that the high-level event convened by the UN Secretary-General in 2014 provides the needed spark.

1.2. "Special Circumstances" of Turkey: chronology & rationale of the debate

The figure below tries to summarize the current situation of Turkey with regard to the Organisation for Economic Cooperation and Development (OECD) and the Annexes (1 and 2) of the UNFCCC:

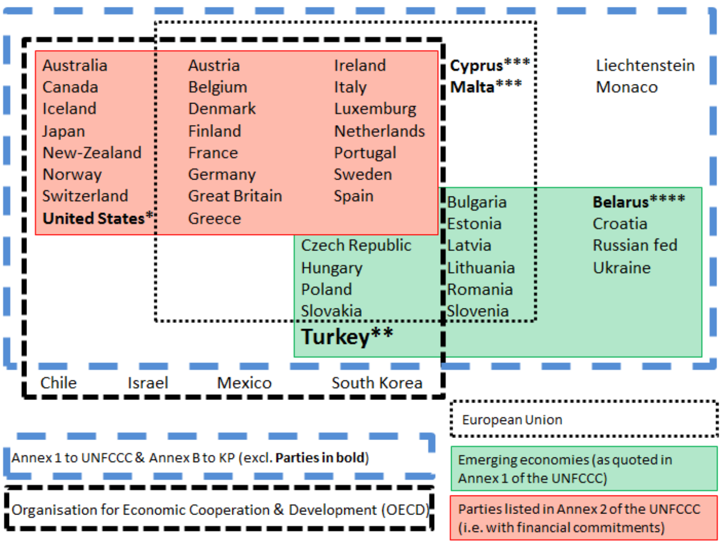

Figure 1 - Turkey in the OECD & Annexes 1 & 2 of the UNFCCC (BOUYER, 2014)

Five countries are in a particular situation:

- USA(*): they signed the KP, but did not ratify it and have no commitment under the Annex B to the KP;
- Turkey (**): part of the Annex 1 but with "specific circumstances" (explained below) and, as such, not included in Annex 2 of the UNFCCC, nor in Annex B to the KP;
- Cyprus and Malta (***): considered as developing country at the time of Kyoto, and not included in the Annex B;
- Belarus (****): also part of the Annex 1 but not included in Annex B to the KP (Decision 10/CMP.2 amending the Annex B with Belarus never approved by other Parties).

Since 1992, Turkey have been advocating for the recognition of its special circumstances. Thus, at the article 35 of the Report of the second part of the fifth session of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change, it is quoted that "*Three delegations (Bulgaria, Czechoslovakia and Turkey) reserved their positions regarding the listing of countries in the Annexes to the Convention*" (UN General Assembly, 1992).

In 1997, Turkey exposed its positions in details in a submission sent to the Secretary of the UNFCCC (UNFCCC, 1997): (i) Turkey wants to be considered as a developing country, and (ii) Turkey requests its deletion from the Annexes 1 and 2 of the UNFCCC. To substantiate its positions, the following key facts were highlighted:

- "*Turkey, with approximately 64 million inhabitants in mid-1997, is one of the most populous countries in the world, and has the fastest population growth rate of all OECD countries (1.6% in 1997). Population is rapidly urbanizing at 4.4%. By 2000, 70% of the population will be living in urban areas. Life expectancy is slightly better than the average of lower middle-income countries; under-five mortality rate is similar. Turkey has been growing at double the average for OECD countries […] As can easily be seen, Turkey is a developing country and still has some burdens to overcome regarding social and economic development*";
- "*Turkey's contribution to global GHG emissions is considerably below the average of Annex 1 countries. Turkey has the lowest energy related CO2 emissions per capita among International Energy Agency (IEA) countries*";
- "*Turkey is acknowledged as a developing country in the Montreal (Ozone) Protocol, relying on the fact that the World Bank, OECD and the United Nation Development Programme (UNDP) have classified Turkey as a developing country*".

In 1998, at COP4 in Buenos-Aires, the Decision 15/CP.4 opened an agenda item to consider the possible deletion of Turkey from the Annexes 1 and 2, pursuant to a joint proposal made by Pakistan and Azerbaijan (UNFCCC, 1999).

In 2001, at COP7 in Marrakech, the Decision 26/CP.7 finally vindicated Turkey, by (i) "*Deciding to amend the list in Annex 2 to the UNFCCC by deleting the name of Turkey*", and (ii) "*Inviting the Parties to recognize the special circumstances of Turkey, which place Turkey, after becoming a Party, in a situation different from that of other Parties included in Annex 1 to the UNFCCC*" (UNFCCC, 2001).

In 2004, Turkey ratified the UNFCCC. Five years later, in 2009, Turkey ratified the KP.

In 2010, in advance to COP16 in Cancun, Turkey exposed its views, related to the preparation of an outcome to be presented to the COP16, in a submission sent to the Secretary of the UNFCCC (UNFCCC, 2010): (i) "*Turkey's historical GHG emissions, per capita GHG emissions, basic economic and social indicators, as well as its sustainable development needs, are significantly different from other Annex 1 Parties*", (ii) "*Turkey is located in one of the most vulnerable regions exposed to the adverse effects of climate change, according to the fourth Assessment Report of the IPCC*", (iii) "*Turkey needs support for finance, technology and capacity building for mitigation and adaptation*".

In 2010, at COP16, the article 142 of Decision 1/CP.16 recalled the key elements of the Decision 26/CP.7 (UNFCCC, 2011): deletion of the name of Turkey from the Annex 2 of the UNFCCC, invitation to Parties to recognise the special circumstances of Turkey placing it in a situation different from that of other Annex 1 Parties, eligibility for support under Article 4, paragraph 5, of the UNFCCC.

It also requested the AWG-LCA "*to continue consideration of these issues with a view to promoting access by Turkey to finance, technology and capacity-building in order to enhance its ability to better implement the Convention*".

In 2011, at COP17 in Durban, the article 170 of Decision 1/CP.17 recalled the key elements of the Decision 26/CP.7 and Decision 1/CP.16 (UNFCCC, 2012).

Since then, after COP18 in Doha and COP19 in Warsaw, the situation stayed the same: (i) Turkey is an Annex 1 Party, having specific circumstances making it different from the other Annex 1 Parties, (ii) Turkey is not part of the Annex 2 of the UNFCCC, and thus not expected to contribute to the climate financing regime, but rather to benefit from it, (iii) Turkey does not have binding GHG emission reduction commitment inscribed in Annex B to the KP.

Perhaps more than for any other Party, the current debates on differentiation between Annex 1 vs Non-Annex 1, as well as the implementation of the UNFCCC principles (historical responsibility, CBDR, equity, etc.) are of interest for Turkey.

1.3. REDD+ vs LULUCF: key features and potential access/interest for Turkey

"Biological" carbon fluxes (carbon removed from the atmosphere by photosynthesis or emitted to the atmosphere by biomass burning or decay), as well as CH4 and N20 (emitted to the atmosphere, respectively by biomass burning or anaerobic fermentation, and aerobic fermentation), are considered in two mechanisms, LULUCF and REDD+, which key features are as follow:

	LULUCF	**REDD+**
Developed acronym	Land Use, Land Use Change, and Forestry	Reducing Emissions from Deforestation and forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
Umbrella body	Initially: KP1 (2008-2012). Now: KP2 (2013-2020)	UNFCCC
Key Decision	16/CMP.1 (Marrakech Accord)	2/CP.13 (Bali Decision on REDD+)
Concerned Parties UP TO 2020	• Developed countries included in Annex 1 of the UNFCCC, AND • Having taken quantified GHG emissions reduction commitments (i) under the KP1, and included in Annex B or (ii) under the KP2, and included in the Doha KP amendment (Decision 1/CMP.8)	Developing countries, not included in the Annex 1 of the UNFCCC
Concerned Parties AFTER 2020	A post-2020 multilateral climate treaty is being prepared under the ADP (Durban Platform), with the aim of having it adopted in COP21, 2015. In this context, the classification Annex 1 vs Non-Annex 1 is being discussed, taking into account UNFCCC principles: CBDR, Historical responsibility, Equity, etc.(see **part 1.2 supra**). At this stage, it is not possible to prejudge what will be the final classification, but there is a probability that some Parties (e.g. BASIC, OECD) not yet included in the Annex 1 could be included in the Annex 1.	
Objective	Reward net removals from forest/agric. sinks (see **part 2 infra**): • Under Art. 3.3 of the KP: net removals from Afforestation/Reforestation done after 1990 (A/R). This accounting is compulsory • Under Art. 3.4 of the KP: net removals from managed forests in existence before 1990 (FM) as well as their derived Harvested Wood Products (HWP). Accounting is compulsory. • Under Art. 3.4 of the KP: net removals from revegetation (woody vegetation not considered as forest) and/or cropland and/or grassland and/or wetlands. Accounting is voluntary.	Reward increased net removals or avoided emissions from the following activities: • Avoiding emissions from Deforestation (1st D); • Avoiding emissions from Degradation (2nd D); • Increasing net removals from A/R (in the "+") • Increasing net removals from forest management (in the "+"). REDD+ is a voluntary mechanism.
Political requirement	• To be part of the KP and have a binding commitment • To have proposed the reference level for FM accounting under art. 3.4, and to have indicated the other selected activities (if any) under art. 3.4	To propose a Readiness Preparation Proposal (RPP): identification of institutional arrangements, drivers of DD and REDD+ options, roadmap for the elaboration of the reference level and the MRV of forest carbon stocks, etc.
MRV requirement	To have a MRV system in place in accordance with IPCC guidelines on LULUCF	The same, but with more flexibility (i.e. to have a MRV on "top of the art", according to its national capacities)
"Main costs"	• Costs of getting prepared for either LULUCF or REDD+ (e.g. reference level for Art. 3.4 FM, RPP, etc.) • Costs of implementation of "pro-climate" forestry and agriculture activities • Costs of running the MRV system	
"Main benefits"	• Carbon: Removal Units (RMUs) which are fungible with other "normal" Kyoto Units (it can lessen the emission reductions in the fossil sectors). Amount of RMUs = f(accounting rules for Art. 3.3 and 3.4) • Non-carbon (tradable/non-tradable goods/services): employment, taxes, timber, Non Wood Forests Products (NWFPs), etc. Depends on selected activities under LULUCF	• Carbon: subsidies for preparation phase and payments for avoided emissions or increased net removals, either through carbon market (voluntary for now. May be regulated under a post-2020 agreement?) or carbon funds (public or private). Amount of payment = f(REDD+ options implemented) • Non-carbon: the same as for LULUCF. Also depends on the REDD+ options implemented

Table 1 - REDD+ vs LULUCF: key features (BOUYER, 2014)

It is worth noting that the concept of Nationally Appropriate Mitigation Action (NAMA) sometimes overlaps with the concept of REDD+. Indeed, these two mechanisms were created under the "mitigation pillar" of the Bali Action Plan, respectively defined in article 1 (b) (i) and article 1 (b) (ii) of the Decision 1/CP.13 (UNFCCC, 2008), and, they both apply to developing countries.

Theoretically, nothing prevents Non-Annex 1 Parties to set up NAMAs in their forestry sectors (as did Mali. see http://namadatabase.org). However, due to the lack of guidance and funding for the design and implementation of NAMAs, six years after the Bali Conference, there are only 72 registered NAMAs: three implemented, nine in preparation, 54 at the concept stage, six with unknown status (situation as of October 2013, Ibid).

Even more striking, the development of NAMAs seems to have slowed: from October 2011 to October 2012: the number of NAMAs increased from 15 to 54 (+300%); from October 2012 to October 2013, this number increased from 54 to 72 (+50%). It can be interpreted as a sign of a loss of confidence in the climate negotiations and/or the capitalisation of the Green Climate Fund.

There are different interpretations of the Art. 142 of Decision 1/CP.16 and Art. 170 of Decision 1/CP.17 regarding "specific circumstances" of Turkey and its eligibility to NAMAs: "*Turkey is fully eligible for support in development of NAMAs*" (UNDP, 2011) vs "*Since Turkey is an Annex 1 country, availability of NAMA finance in the post-2012 period for Turkey has not been clarified yet. Negotiations regarding Turkey's status are ongoing*" (NCCAP, 2011).

Anyway, considering, on the one hand, the current rules governing the LULUCF and REDD+ (and NAMAs) mechanisms, and, on the other hand, the current classification of Turkey under the UNFCCC, as a developed country included in the Annex 1 of the UNFCCC, the only mechanism that may theoretically apply to Turkey is the LULUCF mechanism. It is consistent with the following processes:

- Preparation of a post-2020 multilateral climate treaty: in that context, it is conceivable to have a "reclassification" of Annex 1 vs Non-Annex 1 and an increased pressure put on Annex 1 Parties to take binding commitments (see **Part 1.1 supra**);
- Alignment with the EU Acquis: Since the European Council of Helsinki in 1999, Turkey is a candidate to the EU. Accession negotiations started at the European Council of Copenhaguen in 2002, and the national programme for the adoption of the European Acquis started in 2003. As part of this programme, Turkey has to align with the EU Acquis in the field of climate change, especially as the 2013 progress report on Turkey - Enlargement Strategy and Main Challenges 2013-2014 deplored there that was "*no progress*" in that field (European Commission, 2013).

  This progress report further regrets the "*lack of an overall domestic GHG emissions target in Turkey's national climate change action plan*" but notes that "*preparations on setting up and implementing a MRV system, regulatory and sectoral impact assessments of EU climate policy, and capacity building on LULUCF […] are continuing*", and finally "*invites the country to start reflecting on its climate and energy framework for 2030, in line with the EU Green Paper 'A 2030 framework for climate and energy policies*'".

1.4. Summary: Turkey in the current/future climate regime, incl. LULUCF

Turkey is an Annex 1 Party with "Specific circumstances": because of its fastest population growth rate among all OECD countries and its lowest energy related CO2 emissions per capita among IEA countries, the name of Turkey was deleted from the Annex 2 of the UNFCCC and Turkey was not included in the Annex B of the KP1.

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 it seems useful to explore the possible consequences of such a revisiting of the classification.

Based on the foregoing, the present study aims at providing for a neutral costs and benefits assessment of implementing LULUCF accounting rules in Turkey in the future, as one possibility among other. The rationale for this assessment is based on a technical and objective deduction and does not, in any way, pre-empt the national positions put forward by Turkey in the climate negotiations, nor any possible COP Decision that may precise its future classification, taking into account its specific circumstances.

2. LULUCF accounting rules: initial ones (KP1) & upgraded ones (KP2)

Roughly summarised, the LULUCF accounting rules are divided into two parts: GHG emissions and removals from the forest land, and GHG emissions and removals from other land uses (cropland, grassland, wetlands, and revegetation). As the initial focus was on forest land, when the LULUCF negotiations started in the late 90's, and as the forest sector has still more prominence in the LULUCF accounting rules (see **Parts 2.2 and 2.3 infra**), this study will mainly focus on GHG emissions and removals from the forest land.

2.1. Great mitigation potential in the forest sector, difficult to realise by the KP

➔ Great mitigation options in the forest sector

There are many:

- Avoided deforestation and forest degradation: the most obvious! 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 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 forest, gains can vary from few tCO2eq (avoiding forest degradation) to hundreds of tCO2eq/ha (avoiding deforestation);
- Sustainable Forest Management (SFM): carbon removals in existing forests can be improved, using selected species, lengthening rotations, rejuvenating old forest stands, etc. In temperate forest, gains are in the order of few tCO2eq/ha/year (but the cumulative effect multiplied by the surface considered can be interesting);
- Afforestation/Reforestation (A/R): it covers different modalities of conversion of non-forest land into forest land (planting, seeding, assisted natural regeneration, etc.). In temperate forest, gains are in the order of few tCO2eq/ha/year, rarely more than 10-15 tCO2eq/ha/year (apart from fast growing exotic species);
- Substitution of fossil fuel: wood (firewood, wood pellets, granulated wood, etc.) can be used for energy production (heat and/or electricity). It is 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 tCO2eq;
- Carbon storage in Harvested Wood Products (HWP): carbon can be stored in long-life wood products (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 CO2 in the atmosphere), then one cubic meter of wood equals to one tCO2eq avoided;
- Substitution of "grey energy" in building and housing materials: The grey energy content of HWP used as building and housing materials is much lower than "fossil" materials (iron, concrete, glass, etc.) In France, one cubic meter of wood used as building or housing material avoids 0.8 tCO2eq in average (*Institut technologique Forêt-Cellulose-Bois-construction-Ameublement* – FCBA, 2011).

These mitigation options can be represented graphically, using a theoretical example: one ha of reforestation, with thinning at 40 and 80 years; final cut at 100 years; use of HWP for short-lived and long lived forest products; disposal on landfill for a part of the thinning; use of wood energy in replacement of fossil fuel. NB: area in light purple = substitution of "grey energy" in building and housing materials; area in deep purple = substitution of fossil fuel:

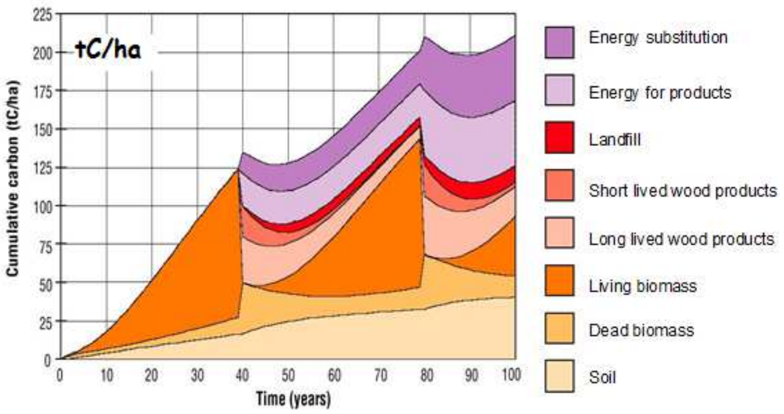

Figure 2 - Mitigation options in the forest sector (MARLAND & SCHLAMADINGER, 1999)

➔ The difficulty to realise the mitigation potential

The Stern Review: the Economics of Climate Change highlighted the fact that "*Terrestrial ecosystems, especially through reducing GHG emissions from deforestation could provide 15% to 30 % of the necessary GHG emission reductions by 2050 to stay below the threshold of 550 ppm of CO2 [path to keep under the +3°C]*" (STERN and al., 2006)

The fourth IPCC Assessment Report further corroborated that "*Forest can make a very significant contribution to the mitigation of climate change at low cost, in synergy with adaptation and sustainable development [...] But this opportunity is lost in the current institutional context and the lack of political will, which led to the creation of a very small portion of this potential so far*" (IPCC, 2007).

Indeed, at the time the KP was discussed, there were technical constraints to realise the full mitigation potential of the forest sector, due to the expected difficulty to report and account for GHG emissions/removals in the forest sector:

- High inter-annual and intra-annual variability of the forest carbon sinks. For instance, the 2004 drought in Western Europe had almost stopped the sink function of certain forests;
- Vulnerability of forest carbon stocks. For instance, a massive pine beetle attack in the Canadian forests destroyed more than three Mha/yr from 2007 onward;
- Non permanence: the carbon should be stored in HWP for 100 years (average lifetime of CO2 in the atmosphere) so that we have equivalence between storage and avoided emission;
- Non additionality: for several decades, carbon removals in forests have increased thanks to indirect anthropogenic factors, such as (i) the increase of CO2 concentration in the atmosphere, (ii) the increase of nitrogen deposition (mainly due to the increased use of chemical fertilisers), (iii) the lengthening of the growing season.

There were also three political constraints:

- Lack of scientific knowledge and consensus on forest sinks: in 1997, at the time Kyoto was discussed, only two IPCC assessment reports were published (first one in 1988 and second one in 1995) and none of them gave details about the pros and cons of mitigation actions in the forest sector. Policy-makers were virtually progressing blind on LULUCF;
- Fear of a dilution of efforts: environmental NGOs feared that developed countries could use forest sinks "for free" and without limit, at the expense of "real" efforts to reduce GHG emissions in their fossil sectors;
- Inverted agenda: the principle of using the LULUCF was provided for in the KP, at the time the national binding commitments were defined (1997)…But the precise rules and modalities for using the LULUCF (and consequently, their impacts on the said commitments) were finally agreed four year later, in the Marrakech Accord (2001). In 1997, the developed countries had to accept quite similar commitments (in the order of -6% to -8% in 2008-2012 compared to 1990 level) and some of them put pressure for "twisting" the LULUCF accounting rules and keeping their word!

Finally, LULUCF was merely considered as an "adjustment variable" in the overall negotiation process, rather than a promising sector for mitigation which potential should be realised. That is why the LULUCF accounting rules seem so complex and even present some loopholes (see **Parts 2.2 to 2.3 infra**). But the great merit of the LULUCF was to offer "flexibility" for the developed countries: some of them (in particular: Australia, Japan, Russia, USA) would have never agreed to sign the KP without it (GITZ, 2004).

2.2. Initial LULUCF accounting rules: KP1, 2008-2012

➔ Emergence of the LULUCF: from Rio (1992), to Kyoto (1997), and to Marrakech (2001)

The need to preserve "*reservoirs*" ("*a component or components of the climate system where a GHG […] is stored*") and "*sink*s" ("*any process, activity or mechanism which removes a GHG […] from the atmosphere"*) was mentioned in the following articles of the UNFCCC (UNFCCC, 1992):

- Art 4.1 (d): it says that "*All parties shall […] promote sustainable management […] of sinks and reservoirs of all GHG not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems*";

- Art. 4.2 (a): it says that "*Each of these Annex 1 Parties shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of GHG and protecting and enhancing its GHG sinks and reservoirs*";
- Art 12.1 (a): it says that "*Each Party shall communicate to the COP […] a national inventory of anthropogenic emissions by sources and removals by sinks of all GHG not controlled by the Montreal Protocol*".

But the creation of the "LULUCF" was done in two articles of the KP (UNFCCC, 1997):

- Art. 3.3: it says that "*all Annex 1 Parties have to account for net changes in GHG gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990*";
- Art. 3.4: it says that "*all Annex 1 Parties shall provide - before the first Conference of the Parties serving as the meeting of the Parties to the KP (CMP) - for consideration by the Subsidiary Body for Scientific and Technological Advice (SBSTA), data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years*".

  It also says that the CMP shall "*at its first session or as soon as practicable thereafter, decide upon modalities, rules and guidelines as to how, and which, additional human-induced activities related to changes in GHG emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories shall be added to, or subtracted from, the assigned amounts for Annex I Parties […] and that an Annex 1 Party may choose to apply such a Decision*".

Between the COP3 held in Kyoto, in 1997, and the COP7, held in Marrakech, in 2001, there were four years of intense negotiations on the LULUCF, in order to precise the modalities, rules, and guidelines for its accounting:

- Decision 9/CP.4 on LULUCF, adopted in Buenos Aires in 1998 (UNFCCC, 1999);
- Decision 16/CP.5 on LULUCF, adopted in Bonn in 1999 (UNFCCC, 2000);
- Decision 5/CP.6bis on LULUCF, adopted in Bonn in 2001 (UNFCCC, 2001). This Decision gave a good outline of the LULUCF modalities, rules and guidelines (in its part VII) and introduced for the first time an "Appendix Z", where were listed the levels of the "cap" to be applied on the activity "Forest Management" (FM) under the article 3.4 of the KP (see explanations infra).

Finally, the Decision 11/CP.7 was adopted in Marrakech: it compiles all the elements of the above-mentioned LULUCF Decisions (9/CP.4, 16/CP.5 and 5/CP.6) and presents, in an annex, a draft CMP Decision with detailed modalities, rules, and guidelines for the LULUCF accounting (UNFCCC, 2002).

The elements of this annex were adopted without change in the Decision 16/CMP.1, four years later at the CMP1 in Montreal, 2005 (UNFCCC, 2006). Indeed, such a Decision, related to the Art. 3.3 and 3.4 of the KP, could only be adopted by the CMP…which was created in 2005, after the entry into force of the KP (thanks to the ratification of Russia, the KP having to cover at least 55% of the GHG emissions – 1990 level – and 55 Parties).

In parallel, the IPCC, upon political request from the COP and the CMP and under the technical guidance of the SBSTA, developed technical guidelines and methodologies for the reporting and accounting of the LULUCF emissions:

- Good Practice Guidance for LULUCF, often referred to as GPG-LULUCF 2003 (IPCC, 2003);
- Volume 4 - Agriculture, Forestry and Other Land Use (AFOLU) of the 2006 IPCC Guidelines for National GHG Inventories, often referred to as AFOLU Guidelines 2006 (IPCC, 2006).

These documents were based on the Revised 1996 IPCC Guidelines for National GHG Inventories (IPCC, 1996), the Good Practice Guidance and Uncertainty Management in National GHG Inventories (IPCC, 2000), and the Special Report on LULUCF (IPCC, 2000).

➔ Principles and outline of LULUCF activities for KP1

As said earlier, the Decision 16/CMP.1 compiles the principles, rules, modalities, and procedures for the LULUCF accounting under the KP.

<u>Principles:</u>

They are eight, listed in Art. 1. Among them, three are of particular importance:

- Art. 1 (b): "*consistent methodologies be used over time for the estimation and reporting of these activities*": it implies that any change of methodologies leads to a recalculation of the complete time series;
- Art. 1 (d): "*the mere presence of carbon stocks be excluded from accounting*": the LULUCF accounting rules deal with fluxes (GHG emissions/removals) and not carbon stocks;
- Art. 1 (h): "*accounting excludes removals resulting from: (i) elevated CO2 concentrations above their pre-industrial level; (ii) indirect nitrogen deposition; and (iii) the dynamic effects of age structure resulting from activities and practices before the reference year*". This principle is often referred to as the "factoring out". In practice, this issue has never been addressed, reason why a cap was applied to the activity 3.4 FM (see explanations infra).

In addition to these principles listed in Art.1, many other Articles in the Decision 16/CMP.1 refer to the notion of "human-induced activity": only anthropogenic GHG emissions/removals have to be accounted for.

Activities:

In accordance with the request made in Art. 16 of the Annex to the Decision 16/CMP.1, the concept of forest has to be nationally-defined with three criteria: minimum area of land (0.05 to 1 ha), minimum tree crown cover at maturity (more than 10% to 30%), minimum height at maturity (2 to 5 metres). A young forest yet to reach the minimum tree crown cover and/or height is included in this definition, as well as a forest temporarily unstocked (harvest, natural cause).

In the frame of the UNFCCC, each Party is expected to report GHG emissions/removals related to certain land use and land use changes. In this UNFCCC land-based inventory, the land is therefore classified in six land uses: Forest, Cropland, Grassland, Wetlands, Settlements, and Other.

In the frame of the KP, each Annex 1 Party is expected to account for GHG emissions/removals related to certain activities. In this KP activity-based inventory, five activities are/may be accounted for:

- Afforestation/Reforestation/Deforestation (ARD), under the Art. 3.3 (mandatory accounting): the three concepts are straight forward, at the single exception than a difference is made between Afforestation (conversion to forest of a land not forested for at least 50 years) and Reforestation (conversion to forest of a land that did not contain forest on 31 December 1989);
- Forest Management (FM), under the Art. 3.4 (voluntary accounting): "*System of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner*";
- Cropland Management (CM) under the Art. 3.4 (voluntary accounting): "*System of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production*";
- Grazing land management (GM) under the Art. 3.4 (voluntary accounting): "*System of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced*";
- Revegetation (RV), under the Art. 3.4 (voluntary accounting): "*Direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of A/R contained here*".

➔ Detailed accounting modalities for Article 3.3 (ARD)

The Art. 3.3 of the KP is mandatory, and aims at promoting A/R and limiting deforestation. The accounting modalities are quite easy to understand: every year, between 2008 and 2012, annual GHG emissions due to deforestation made after the 31 December 1989 are subtracted from GHG removals due to A/R made after the 31 December 1989.

For instance, considering the 2010 KP inventory, the GHG removals allowed in 2010 by a plantation made in 1993 will be accounted for. Inversely, the GHG emissions caused in 2010 by a deforestation made in 1999 will also be accounted for (in that case, it will only be GHG emissions coming from the soil, the litter or the dead wood. It is usually considered that carbon contained in the living biomass, above-ground or below ground, is emitted the same year than the deforestation).

If the balance is positive (removals > emissions = "credit"), then it generates Removal Units (RMUs), that are fully fungible with Assigned Amount Units (AAUs) and can be used by the Party to respect its commitment.

If the balance is negative ("debit"), it can be "compensated" by a "credit" under the Art. 3.4 – activity FM, up to 9 MtC/year or 32.4 MtCO2/year…This surprising rule (Art. 10 of the Annex to the Decision 16/CMP.1) is known as the "Debit-credit rule". At any shots you win! It makes it nearly impossible to be penalised for deforestation.

Two other rules are also a bit surprising:

- "*Fast forest fix*" (Art. 4 of the Annex to the Decision 16/CMP.1): it allows not to account for certain types of deforestation "*debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than credits accounted for on that unit of land*";
- "*Australian clause*": this clause is not contained in the Decision 16/CMP.1, but in the KP itself (Art. 3.7 of the KP). It says: "*Those Parties included in Annex I for whom LULUCF constituted a net source of GHG emissions in 1990 shall include in their 1990 emissions base year the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount*". In plain language, it means that a country having a lot of deforestation in 1990 can be rewarded, with RMUs generated under the Art. 3.3 of the KP, if only it reduces its deforestation…

➔ Detailed accounting modalities for Article 3.4

As presented earlier, under this Art. 3.4, four activities can be voluntary elected: FM, CM, GM, and RV. The aim of these activities is to promote the sustainable use of the land and increase GHG removals. Their accounting rules are different:

- For Art. 3.4 FM, the accounting methodology is called "gross-net with a cap". Indeed, every year between 2008 and 2012, GHG emissions/removals of "pre-1990" forests (NB: need to differentiate forests covered under Art. 3.3 to those covered under this activity) are accounted for ("net"), BUT not compared to the GHG emissions/removals of "pre-1990" forests in the base year 1990 ("gross").

  As the balance can be huge (e.g. around 70 MtCO2eq/year for France between 2008 and 2012, i.e. around 13% of its total GHG emissions), a "cap" is applied (e.g. 3.2 MtCO2eq/year for France). The levels of the caps were initially set up at 15% of the estimated balance of GHG emissions/removals of "pre-1990" forests in the base year 1990…

  But the negotiations on this topic looked like a bargaining, rather than objective negotiations guided by science (even if the footnote 5 related to Art. 11 of the Annex of the Decision 16/CMP.1 tries to demonstrate that a sound scientific reasoning was followed!). Finally, the levels of the cap contained in the Appendix Z to the Decision 5/CP.6bis on LULUCF, adopted in Bonn in 2001, were set up to get all Annex 1 Parties happy.

- For Art. 3.4 CM / GM / RV, the accounting methodology is called "net-net". Indeed, every year between 2008 and 2012, GHG emissions/removals for CM or GM or RV are accounted for ("net"), AND compared to the GHG emissions/removals for the same activity in the base year 1990 ("net").

  For a given activity (CM or GM or RV), if the balance is positive (removals > emissions = credit), then it generates RMUs, that are fully fungible with AAUs, and can be used by the Party to respect its commitment. If not, then the Party has to compensate the "debit".

  Almost all Annex 1 Parties elected the activity FM, because credits were almost assured. Very few elected other activities, where credits were uncertain.

➔ Implications of Art. 3.3 and 3.4 on the promotion of biomaterial and bioenergy

As said earlier, the KP was adopted in 1997 and the LULUCF rules were set in 2001: at that time, the functioning of carbon sinks was little known. By default, during the KP1, it was considered that HWP were immediately oxidized at harvest.

Under this assumption, the carbon storage effect of HWP is not promoted. At least, the substitution effect of the HWP is taken into account if it replaces domestically-produced building or housing material with higher “grey energy” content: it decreases the GHG emissions in the “energy” and “industry” sectors of the GHG inventory.

The assumption of “instant oxidization” has another consequence: GHG emissions from biomass burning are not accounted for, to avoid double counting (e.g. if the carbon contained in the HWP is accounted for in the forest, it should not be accounted for a second time in the biomass boiler).

Therefore, as (i) GHG emissions of pre-1990 forests are partially accounted for (e.g. in France, to follow with the same example: the pre-1990 sink was around 70 MtCO2eq/year and the cap was set at 3.2 MtCO2eq/year. It would have been possible to harvest many Mm3 of wood without passing below the cap!), and as (ii) GHG emissions from biomass burning are not accounted for, there is a perverse incentive to promote unsustainable use of bioenergy.

➔ Synthesis of incentives / safeguards in the LULUCF sector, for KP1

	Avoiding GHG emissions from deforestation ➔ Nothing: loophole with art. 3.7 (“Australian clause”) and possible debit under Art. 3.3. ARD compensated up to 9 MtC/year by a credit under Art. 3.4 FM
Strong incentive and/or strong safeguard	Increasing GHG removals by A/R ➔ Credit under Art. 3.3 if balance GHG emissions – removals > 0
	Increasing GHG removals by pre-1990 forests ➔ Credit under Art. 3.4 if balance GHG emissions – removals > 0… But exotic accounting (“gross-net” with cap) that does not reward effort nor avoid abuse
Moderate incentive and/or moderate safeguard	Increasing GHG removals by CM, GM, RV ➔ Credit under Art. 3.4 if balance GHG emissions – removals > 0 and straight forward accounting (“net-net”)
	Increasing carbon storage in HWP ➔ Nothing (assumption of instant oxidization)
	Avoiding GHG emissions by substituting fossil fuels with wood energy ➔ GHG emissions from biomass burning not accounted for (possible perverse incentive to develop non sustainable use of wood energy)
Poor incentive and/or poor safeguard	Avoiding GHG emissions by substituting “fossil” materials with HWP ➔ Indirect effect (less GHG emissions in the fossils sectors, if domestically-produced HWP)

Figure 3 - Synthesis of incentives / safeguards in the LULUCF sector for KP1 (BOUYER, 2014)

2.3. Current LULUCF accounting rules: KP2, 2013-2020

From the launching of the AWG-KP at the COP11 in Montreal, 2005, negotiations started again on LULUCF, with a view to set up the “new” LULUCF rules before the KP2 commitments and avoid the Kyoto/Marrakech inverted agenda. Negotiations were not only carried out in the frame of the UNFCCC and its KP, but also through an informal LULUCF dialogue between LULUCF experts (out of the UNFCCC), punctuated by technical workshops. Three major Decisions were adopted on this issue:

➔ Key changes from Cancun (2010): Decision 2/CMP.6 (UNFCCC, 2011)

This Decision says that the principles and definitions contained in the Decision 16/CMP.1 should remain the same (Art. 1 and Art. 2 respectively), and that the AWG-KP should consider the need to put a cap on Art. 3.4 FM and how to address “*extraordinary occurrences (called force majeure) whose severity is beyond the control of, and not materially* influenced by, a Party” (Art. 3).

Last but not the least, it also says that each Annex 1 Party should submit “*information on the forest management reference level (FM REL) inscribed in Appendix I to this Decision, in accordance with the guidelines outlined in Part I of Appendix II to this Decision*” (Art. 4) and that “*each submission […] shall be subject to a technical assessment by a review team in accordance with the guidelines outlined in Part II of Appendix II to this Decision, and that outcomes of the technical assessment will be considered by the CMP7*” (Art. 5).

With regard to the FM REL inscribed in Appendix I, the footnote 1 of the Decision says "*The FM REL were set transparently, taking into account the following: (a) removals or emissions from forest management as shown in GHG inventories and relevant historical data; (b) age-class structure; (c) forest management activities already undertaken; (d) projected forest management activities under a 'business as usual' scenario; (e) continuity with the treatment of forest management in the first commitment period; (f) the need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1* [NB: factoring out]".

Some of the criteria in this list seem a bit vague (e.g. many ways to understand "*forest management activities already undertaken*" or "*continuity with the treatment of forest management in the first commitment period*"). Furthermore, the footnotes later says that "*Points (c), (d) and (e) above were applied where relevant*"…Which mean that Parties considered these criteria as forming part of a shopping list.

For instance, the Russian Federation and Norway considered only historical data (i.e. level of the FM sink in 1990) and did not use projections. Others like Finland and Sweden, having developed their wood energy sectors and having a decreasing sink compared to historical level, were strongly in favour of using a projected FM REL, in order not to get "penalised". Knowing that the assumption of carbon neutrality of biomass burning was not questioned, this latter position could be discussed (i.e. increase of CO2 emissions due to the development of bioenergy is not captured in the energy section of the national KP GHG inventory, nor in the LULUCF section of the national KP GHG inventory).

Anyway, Annex 1 Parties submitted their proposed FM REL prior to CMP6 and the Decision 2/CMP.6 requested them to justify their calculation, providing *ex-post* the guidelines for setting these FM REL in the Part I of Appendix II to the Decision. This process seems a bit illogical (i.e. it would have been better to get the guidelines *ex-ante*), but it happens in the negotiations.

The Art. 5 of this Part I says that "*Parties shall […] provide a description on how each element contained in footnote 1 in paragraph 4 of this Decision was taken into account in the construction of the FM REL*". The Art. 9 of this part I refines the criteria inscribed in the footnote 1, requesting information on "(*c) Forest characteristics, including age-class structure, increments, rotation length […]; (d) Historical and assumed harvesting rates; (e) HWP; (f) Disturbances in the context of force majeure; (g) Factoring out in accordance with paragraph 1 (h) (i) and (ii) of Decision 16/CMP.1* [NB: 1 (h) (i) is about elevated CO2 concentrations, 1(h) (ii) is about indirect nitrogen deposition]".

The Art. 11 and Art. 12 of this Part I further refine the criteria inscribed in the footnote 1, requesting respectively "*a description of the domestic policies adopted and implemented no later than December 2009*", and "*confirmation that the construction of the FM REL neither includes assumptions about changes to domestic policies adopted and implemented after December 2009 nor includes new domestic policies*".

The Part II of Appendix II to the Decision then describes the review process in details, highlighting the fact in that "*As part of the technical assessment, the review process may provide technical recommendations to the Annex I Party on the construction of its FM REL. This may include a recommendation to make a technical revision to elements used in its construction*" (Art. 16 of Part II), "*Review teams shall refrain from making any judgment on domestic policies taken into account in the construction of the FM REL*" (Art. 17 of Part II), and "*If the Party does not agree with the findings in the draft report, […] the review team will seek advice from a small group of experienced reviewers to be convened by the secretariat, which will consider comparability across Parties*" (Art. 31 of Part II)

At the end of the review process, the Secretariat was requested to prepare a synthesis report of key conclusions of the FM REL review process, including comments by Parties, for consideration at the CMP7 (Art. 33 of Part II).

➔ Key changes from Durban (2011): Decision 2/CMP.7 (UNFCCC, 2012);

This Decision opens four negotiation topics, to explore: "*a more comprehensive accounting*" (Art. 5), "*additional LULUCF activities under the Clean Development Mechanism (CDM)*" (Art. 6), "*alternative approaches to addressing the risk of non-permanence under the CDM*" (Art 7), "*the concept of additionality*" (Art. 10). It also invites the IPCC to provide for supplementary guidelines for the LULUCF part of KP inventories (Art. 8) and requests the SBSTA to consider these supplementary guidelines with a view to forward a draft CMP Decision for adoption at CMP10 (Art. 9).

Most important, it adopts: "*definitions, modalities, rules and guidelines relating to LULUCF contained in the Annex to this Decision for application in the second commitment period*" (Art. 11). A great part of the elements contained in the Annex are copied and pasted from the Decision 16/CMP.1. Below are highlighted the addition/deletion made in this Annex, as compared to the Decision 16/CMP.1:

- Definitions: Two definitions are added to the existing ones contained in the Decision 16/CMP.1:
    - "*Natural Disturbances*": *"[…] non-anthropogenic events or non-anthropogenic circumstances […] that cause significant emissions in forests and are beyond the control of, and not materially influenced by, a Party. These may include wildfires, insect and disease infestations, extreme weather events and/or geological disturbances, beyond the control of, and not materially influenced by, a Party. These exclude harvesting and prescribed burning*" (Art. 1 (a));
    - "*Wetland drainage and rewetting*": "*a system of practices for draining and rewetting on land with organic soil that covers a minimum area of one hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined in this annex, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage*".

Annex 1 Parties that did not select a definition of forest for the KP1 (NB: like Turkey) shall do it, on the basis of the definition of "forest" contained in Art. 1 (a) of the Annex to Decision 16/CMP.1

- Art. 3.3: The "Fast-forest-fix" (Art. 4 of the Annex to the Decision 16/CMP.1) and the "Debit-credit rule" (Art. 10 of the same Annex), already described (see **Part 2.2 supra**), disappear. A new article appears: "*Each Annex 1 Party shall report and account for, in accordance with Article 7, all emissions arising from the conversion of natural forests to planted forests*" (Art. 5).

  The Art. 7, quoted in Art. 5, refers to the activity FM under Art. 3.4 of the KP. Therefore, this new article does not change practices under the KP1, where any decrease of carbon stock in pre-1990 forest (through a conversion of natural forests to planted forests for instance) was to be accounted for. The important aspect is that Art. 7 made accounting of FM under Art. 3.4 of the KP mandatory, while it was not the case before.

- Art. 3.4: CM, GM and RV are still voluntary elected and accounted "net-net" compared to the base year 1990 (Art. 6), and a new voluntary activity appears: "*Wetland Drainage and Rewetting*" (WDR), also accounted "net-net" compared to the base year 1990 (Art. 6). Parties electing this new activity on wetland are invited to use the most recent IPCC guidelines (Art. 11).

  FM becomes mandatory (Art. 7) and FM accounting under Art. 3.4 of the KP is no more "gross-net with a cap" (see **Part 2.2 supra**), but becomes "net-net" compared to the FM REL inscribed in an Appendix to the Annex to the Decision 2/CMP.6 (Art. 12).

  In order to respond to the G77+China concern over the risk of "manipulation of numbers" and dilution of Annex 1 Parties' commitments, a "new cap" is established: RMUs generated by the FM activity under Art. 3.4 of the KP and FM projects carried out in another Annex 1 Party (thanks to the Joint Implementation (JI) mechanism, allowed by Art. 6 of the KP) shall not exceed 3.5% of the total GHG emissions without LULUCF in the base year 1990 (Art. 13).

  Methodological guidelines are also provided for, with regard to the accounting for FM: (i) Parties shall demonstrate consistencies between the FM REL and the reported emissions/removals for FM. In particular, the same assumptions should apply when considering the surface area under FM, the HWP, and the natural disturbances (Art. 14), (ii) If any change is done to the data used to set up the FM REL, this REL shall be recalculated (Art. 15).

- HWP: It related to Art. 3.3 and Art. 3.4 FM. Detailed guidelines are provided for their accounting:
    - HWP is added at a sixth pool (see **Part 2.4 infra**) and shall be accounted for under Art. 3.3 and Art. 3.4 FM (Art. 26);
    - Imported HWP shall not be accounted for by the importing Party (Art. 27), but a Party can account for its exported HWP (Art. 30);
    - Accounting for HWP shall be on the basis of instantaneous oxidation if the FM REL is based on historical data (Art. 28) and based on "*the first-order decay function (using Equation 12.1 of the AFOLU 2006 Guidelines) with default half-lives (based on Table 3a.1.3. of the GPG-LULUCF 2003) of two years for paper, 25 years for wood panels and 35 years for sawn wood*" if the FM REL is based on a projection (Art. 16 and 29);

  - "*A Party may use country-specific data to replace the default half-lives […] provided that verifiable and transparent activity data are available and that the methodologies used are at least as detailed or accurate as those prescribed above*" (Art. 30);
  - HWP resulting from deforestation and HWP harvested for energy purpose shall be accounted for on the basis of instantaneous oxidation (Art. 31 and Art 32 respectively);
  - Emissions due to HWP removed from forest prior the start of the KP2 should be accounted for if the FM REL is based on historical data, and, at the contrary, not accounted for if the FM REL is based on a projection (Art. 16);

- <u>Natural disturbances:</u> Detailed guidelines are provided for their treatment:
  - If an Annex 1 Party intends to apply this provision for Art. 3.4, it "*shall provide country-specific information in its national GHG inventory report for 2015 on a forest management background level of emissions associated with annual natural disturbances that have been included in its FM REL, how the background level has been estimated and information on how to avoid the expectation of net credits or net debits during the commitment period, including through the use of a margin, where a margin is needed*" (Art. 33 (a)).

    The "*background level*" is defined as the "*average of a consistent and initially complete time series containing 1990–2009 emissions associated with natural disturbances after the application of an iterative process to remove outliers, based on twice the standard deviation around the mean until no outliers can be identified*" (footnote 7) and the "*margin*" is defined as "*twice the standard deviation of the time series defining the background level*" (footnote 8);
  - Under Art. 3.4 FM, a Party "*may exclude from the accounting […] emissions from natural disturbances that in any single year exceed the background level. Any subsequent removals during the commitment period on the lands affected shall also be excluded from the accounting. Parties may only exclude emissions from disturbances in years where those emissions are above the background level plus the margin, where a margin is needed (Art. 33 (a))*";
  - Under Art. 3.3, an Annex 1 Party may use the same mechanism, as described for Art. 3.4 FM in Art. 33 (a) (Art. 33 (b));
  - "*Annex 1 Parties shall account for emissions associated with salvage logging*" (Art. 33 (c));
  - An Annex 1 Party using the "force majeure" clause shall provide information: identification of concerned land (georeferenced location, year and type of disturbances), identification of any future land use change, demonstration that the natural disturbances were beyond the control of, and not materially influenced by, the Party, etc. (Art.33);

- <u>"New Zealand clause":</u> Pinus radiada is extensively planted in New-Zealand, with a short-cycle (28 years in average), and farmers often convert plantations to grazing land or cropland, and vice versa, depending on the commodities prices. Therefore, New Zealand requested and obtained the creation of this ad hoc clause: the deforestation of a plantation established before 1990 (i.e. final cut and then conversion to cropland or grazing land) may not be accounted for under Art. 3.3 ARD, but under Art. 3.4 FM, provided that a new "equivalent forest" is established on a land that did not contain forest after 31 December 1989 and that this newly established forest will reach at least the equivalent carbon stock that was contained in the harvested forest.

  In theory, this clause allows a Party not to be penalised for a "dynamic" land use management. In practice, it may create a bureaucratic burden for the monitoring of the affected land…and few Parties may use it (at least not New Zealand, since it announced in 2013 that it will not engage in the KP2!).

➔ Key changes from Doha (2012): Decision 2/CMP.8 (UNFCCC, 2013)

The Decision 2/CMP.8 does not add much, in substance, to the two last LULUCF Decisions. It rather "codifies" the methodological tasks to be carried out by Annex 1 Parties engaging into the LULUCF, and how these specific LULUCF tasks relate to broader methodological tasks to prepare the implementation of KP2 (in line with Art. 5, 7, and 8 of the KP).

Therefore, the preamble of the Decision 2/CMP.8 cites 21 Decisions (!), relating to various aspects of the KP: calculation of assigned amounts and international registry (Art. 7.4 of the KP), modalities and procedures for the flexible mechanism (JI under Art. 6 of the KP, CDM under Art. 12 of the KP, and carbon market under Art. 17 of the KP), LULUCF (Art. 3.3 and Art. 3.4 of the KP), national inventories (Art. 5.1 and Art. 5.2 of the KP), review and compliance mechanisms (Art. 8 of the KP), etc.

The three key points of this Decision are the following:

- Assigned Amount: Each Annex 1 Party having a binding commitment inscribed at the Annex B to the KP shall submit an "Assigned Amount Report" to the UNFCCC Secretariat, before 15 April 2015 (Art. 2). This report shall include information listed in Annex I to the Decision (Art. 3), in particular: choice of voluntary activities under the Art. 3.4 (Art. 1 (g) of the Annex I), FM REL (Art. 1 (i)), methodological choices to account for HWP (Art. 1 (j)), methodological choices to account for natural disturbances, including the selection of a background level (Art. 1 (k)).

  For Annex 1 Parties that were not inscribed at the Annex B to the KP during KP1, specific information is required: choice of a forest definition (Art. 1 (f)), description of a national inventory system (Art. 1 (l)), and description of a national registry (Art. 1 (m)).

- LULUCF in GHG inventories: Each Annex 1 Party having a binding commitment inscribed at the Annex B to the KP shall submit ad hoc information on LULUCF in their annual GHG inventories (Art. 4). This report shall include elements of information listed in Annex I to the Decision. These elements are related to the accounting rules and modalities described in the Decision 2/CMP.7.
- Further work on GHG inventories: The SBSTA is requested to assess the KP supplementary methodology on LULUCF (Art. 8), and also to assess methodological challenges related to the GHG inventories for KP2 (Art. 6 and Art. 10). It has to be mentioned that, already, Annex 1 Parties are encouraged by various Decisions to use the most updated methodological guidance from the IPCC, i.e. 2013 IPCC Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol and the 2013 IPCC Wetlands Supplement (Rewetting and Drainage methodologies).

➔ Synthesis of incentives / safeguards in the LULUCF sector, for KP2

	Avoiding GHG emissions from deforestation ➔ Still a loophole with art. 3.7 ("Australian clause") but deletion of the "debit-credit rule" (potential debit under Art. 3.3. ARD compensated up to 9 MtC/year by a credit under Art. 3.4 FM)
Strong incentive and/or strong safeguard	Increasing GHG removals by A/R ➔ Credit under Art. 3.3 if balance GHG emissions – removals > 0
	Increasing GHG removals by pre-1990 forests ➔ Credit under Art. 3.4 FM if balance GHG emissions – removals > 0…But exotic accounting ("net-net compared to a FM REL" with cap of 3,5% of 1990 GHG emissions excluding LULUCF)
Moderate incentive and/or moderate safeguard	Increasing GHG removals by CM, GM, RV, WDR ➔ Credit under Art. 3.4 if balance GHG emissions – removals > 0 and straight forward accounting ("net-net")
	Increasing carbon storage in HWP ➔ Accounted for with simple decay approach…But dependent on exotic accounting under Art. 3.4 FM
Poor incentive and/or poor safeguard	Avoiding GHG emissions by substituting fossil fuels with wood energy ➔ GHG emissions from biomass burning not accounted for (possible perverse incentive to develop non sustainable use of wood energy)
	Avoiding GHG emissions by substituting "fossil" materials with HWP ➔ Indirect effect (less GHG emissions in the fossils sectors, if domestically-produced HWP)

Figure 4 - Synthesis of incentives / safeguards in the LULUCF sector for KP2 (BOUYER, 2014)

2.4. Reporting UNFCCC Categories vs Accounting KP Activities

➔ Key concepts in terms of reporting (for the UNFCCC) and accounting (for the KP)

As explained earlier, under Art. 12.1 (a) of the UNFCCC, each Party is expected to report its GHG emissions by sources and removals by sinks. Both national inventories, under the UNFCCC and under the KP, are based on the same methodological guidelines (i.e. Revised 1996 IPCC Guidelines for National GHG Inventories, GPG 2000, later completed by the GPG-LULUCF 2003 and the AFOLU Guidelines 2006). Here below are presented the key-concepts that will be used over the study:

- Activity data and emission factor:

- Activity data: land use and land use changes, expressed in ha/yr;
- Emission factor: carbon stock changes (emissions or removals), as well as CH4 emissions (e.g. due to biomass burning or anaerobic fermentation) and N20 emissions (e.g. due to aerobic fermentation), expressed in tCO2eq/ha

Crossing these values gives GHG emissions/removals (expressed in tCO2eq/yr).

- Carbon pools:

As stated in Art. 21 of the Annex to the Decision 16/CMP.1, "*Each Party included in Annex I shall account for all changes in the following carbon pools: above-ground biomass, below-ground biomass, litter, dead wood, and soil organic carbon. A Party may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that the pool is not a source*." Thus, the principle of "conservativeness" is generally used by Annex 1 Parties for the soil organic carbon, which often proves difficult to be monitored.

- Principles of transparency, accuracy, precision, completeness, comparability, and consistency:

The same principles apply to both national inventories, under the UNFCCC or under the KP: need for transparency, accuracy, precision, completeness, comparability (over time and over Parties), and consistency (over time. In particular, if a methodological improvement is done, it implies that the entire historical data series have to be recalculated).

The "overall uncertainty" on a variable refers to the lack of knowledge of its true value. It may be caused by both random errors, which affect "precision", and systematic errors (or biases), which affect "accuracy", as presented below:

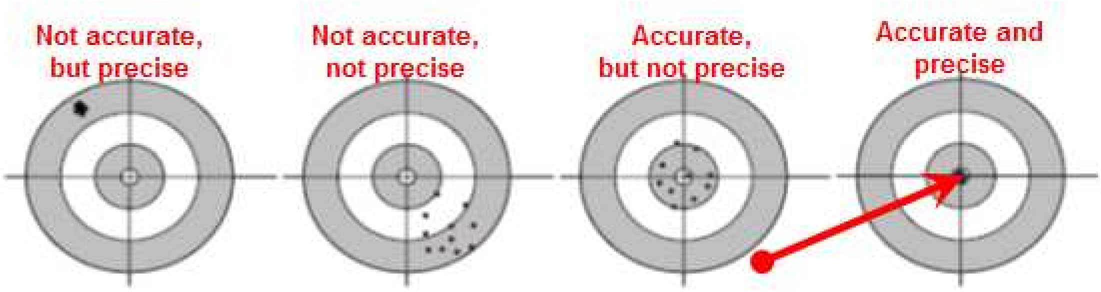

Figure 5 - Concepts of uncertainty, accuracy, and precision (GRASSI et al., 2008)

In order to reduce the overall uncertainty, Quality Assessment (QA) and Quality Control (QC) measures have to be put in place. A simple way to respect the principles of "accuracy" and "precision" is to account for the lower range of the measured value: principle of "conservativeness".

- Levels of "Tier"

As explained in the GPG-LULUCF 2003, three levels of "Tier" can be used by a country:

- The Tier 1 approach "*employs the basic method and the default emission factors provided in the IPCC Guidelines […] Tier 1 methodologies usually use activity data that are spatially coarse, such as nationally or globally available estimates of deforestation rates, agricultural production statistics, and global land cover maps*";
- Tier 2 approach "*uses the same methodological approach as Tier 1 but applies emission factors and activity data which are defined by the country for the most important land uses/activities. Tier 2 can also apply stock change methodologies based on country-specific data. Country-defined*

emission factors and activity data are more appropriate for the climatic regions and land use systems in that country";

- Tier 3 implies "*higher order methods are used including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national to fine grid scales. These higher order methods provide estimates of greater certainty than lower tiers and have a closer link between biomass and soil dynamics. Such systems may be GIS-based combinations of age, class/production data systems with connections to soil modules, integrating several types of monitoring. Pieces of land where a land-use change occurs can be tracked over time".*

<u>- Approaches in terms of monitoring of activity data</u>

The IPCC good practice guidance for LULUCF presents the following three approaches for obtaining activity data:

- Approach 1: only identifying the total area for each land category. At a given date, you know what are the areas under forest, grassland, cropland, etc. but you do not know where and what were the land use changes from one land use category to another;
- Approach 2: same as approach 1 + tracking of land-use changes between land use categories. At a given date, you know what are the areas under forest, grassland, cropland, etc. as well as the areas of land use changes from one land use category to another, but you do not know where these land use changes happened;
- Approach 3: same as approach 2 + tracking of land use changes on an explicit spatial basis, including gross deforestation and gross change in other land cover classes. Therefore, this last approach would be the adequate one for LULUCF accounting under the KP.

<u>- Key category analysis</u>

As explained in the GPG-LULUCF 2003, "*Generally, inventory uncertainty is lower when emissions and removals are estimated using a higher tier. However, these generally require extensive resources for data collection, so it may not be feasible to use higher tier methods for every category of emissions and removals. It is therefore good practice to make the most efficient use of available resources by identifying those categories that have the greatest contribution to overall inventory uncertainty […] It is good practice for each inventory agency to identify its national key categories in a systematic and objective manner. Such a process will lead to improved inventory quality, as well as greater confidence in the emission estimates that are developed*".

To choose the ad hoc methodology to determine the "key category" of sources and sinks in a country, the GPG-LULUCF 2003 provides a decision tree:

Figure 5.4.1 Decision tree to identify key categories of sources and sinks

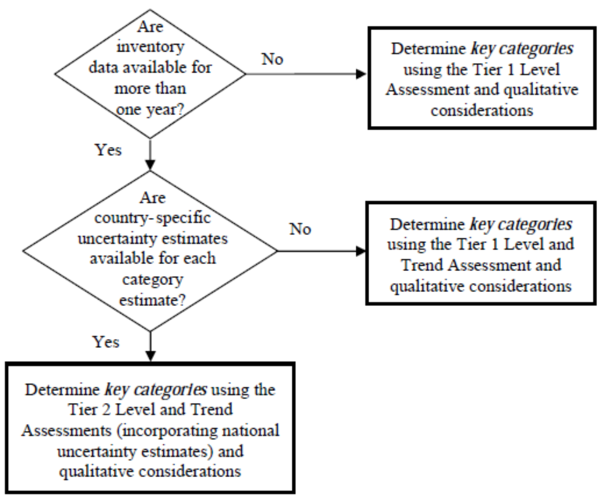

Figure 6 - Decision tree for key categories analysis - Figure 5.4.1 of GPG-LULUCF 2003 (IPCC, 2003)

In the case of Turkey and according to this decision tree, key categories may be identified using the Tier 1 Level and Trend Assessment, and qualitative considerations. Furthermore, the GPG-LULUCF 2003 also suggests the sink categories to be assessed:

TABLE 5.4.1
SUGGESTED IPCC SOURCE/SINK CATEGORIES FOR LULUCF AND NON-LULUCF [a]

Source/Sink Categories to be Assessed in Key Category Analysis	Special Considerations
LULUCF	
Forest land remaining forest land	Assess key categories separately for CO_2, CH_4 and N_2O. If the category is key, assess the significance of subcategories by identifying those that contribute 25-30% to the total level of emissions or removals from the category. For information on the subcategories associated with each category, see Table 3.1.1 and 3.1.3 in Chapter 3.
Croplands remaining croplands	
Grassland remaining grassland	
Wetland remaining wetland	
Settlements remaining settlements	
Conversion to forest land	
Conversion to cropland	In addition to the guidance above, assess the impact of all deforestation occurring within the country according to the qualitative guidance provided in the sixth bullet Section 5.4.3.
Conversion to grassland	
Conversion to wetland [b]	
Conversion to settlements	
Conversion to other land	

Table 2 - LULUCF categories in key category analysis – Table 5.4.1 of GPG-LULUCF 2003 (IPCC, 2003)

➔ Relations between UNFCCC LULUCF Classes and the KP LULUCF Activities for KP2

UNFCCC LULUCF Classes for Reporting KP LULUCF Activities for Accounting.

NB: no reporting for unmanaged forest and grassland

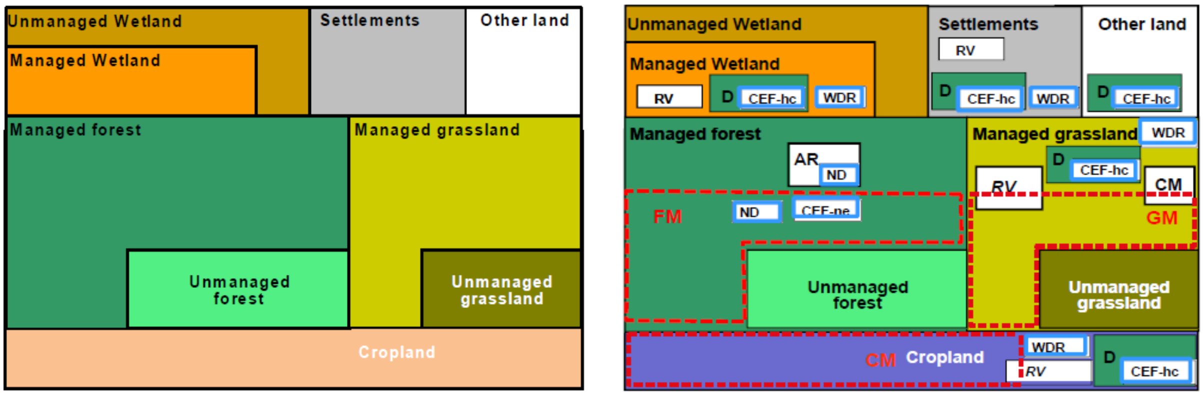

Figure 7 - Comparative mapping of UNFCCC classes and KP activities in LULUCF (SANZ, 2013)

The acronyms in the right part are the following:

AR = Afforestation/Deforestation, D = Deforestation (accounted for under Art. 3.3 of the KP)

FM = Forest Management, CM = Cropland Management, GM = Grassland Management, RV = Revegetation, WDR = Wetland Drainage and Rewetting (accounted for under Art. 3.4 of the KP)

ND = Natural Disturbances, that may happen in AR or FM that are subject to the provision to exclude emissions due to ND from accounting (as per the “Force majeure clause” of Decision 2/CMP.7)

Carbon Equivalent Forest, either areas where trees have been harvested and converted to non-forest land = CEC-hc, or areas where equivalent forest has been newly established = CEC-ne (as per the “New Zealand clause” of Decision 2/CMP.7)

Presented differently, within a matrix of all possible land used changes from one UNFCCC land use class to another, KP LULUCF Activities appear scattered:

Transitions are from the "initial" to the "final" land-use category, indicating which KP Article 3.3 or 3.4 activities may have occurred on that land. Bold font indicates mandatory reporting activities; regular font indicates elective activities where the classification depends on the election of Article 3.4 activities by a country. Note that all possible LULUCF transitions have not been included in this table, only those which can be reported under Article 3.3 or 3.4 activities.

Final / Initial	Forest Managed land	Cropland	Grassland	Wetland	Settlements	Other land
FOREST Unmanaged land**	**FM**	**D****	**D****	**D**	**D**	**D**
Forest Managed land	**FM**	**D****	**D****	**D**	**D**	**D**
Cropland	**AR***	CM, RV, WDR***	CM#, GM, RV, WDR***	CM,RV, WDR***	CM****,RV	CM****
Grassland	**AR*, FM**	CM, GM##, RV, WDR***	GM, RV, WDR***	GM, WDR***	GM****	GM****
Wetland	**AR*, FM**	CM, RV, WDR***	GM, RV, WDR***	RV, WDR***	RV, WDR***	WDR***
Settlements	**AR***	CM, RV, WDR***	GM, RV, WDR***	RV, WDR***	RV	
Other land	**AR*, FM**	CM, RV	GM, RV	RV, WDR***	RV	

WDR: Wetland Drainage and Rewetting.

* If the conversion is direct human-induced then classify as AR which takes precedence over FM and therefore although the land is subject to FM, it is reported under AR. If the conversion is not direct human-induced, and the definition of FM is met, then the land is reported in FM.

**D takes precedence over cropland/grassland categories.

***When elected, WDR only applies on land which is not accounted for under any Article 3.3, FM or other elected Art. 3.4 activity

**** Once land has been reported under any Article 3.3 or 3.4 activity during a CP, it must continue to be reported.

Only if CM is elected and GM is not elected.

Only if GM is elected and CM is not elected.

Figure 8 - Matrix of all land use changes within UNFCCC classes and KP2 LULUCF Activities (SANZ, 2013)

➔ The challenge of land tracking for LULUCF accounting in the KP2

According to the KP supplementary GPG-LULUCF 2013, "*if the area under CM* [NB: it is the same situation for others KP LULUCF activities] *changes between the base year and the commitment period, e.g., due to AR or land moving into another elected activity under the KP, this may lead to estimates on the basis of moving land*".

The figure below highlights this difficulty, which is further increased if the national land use monitoring system suffers from inconsistencies (as in the case of Turkey. See **Parts 3.1 and 3.2 infra**)

BOX 2.9.1
AN EXAMPLE OF CROPLAND MANAGEMENT AREAS IN BASE YEAR AND IN THE COMMITMENT PERIOD (NET-NET ACCOUNTING)

In this example the area under CM in the base year expands to a larger area in the reporting year during the commitment period. Some of the area was under CM in both the base year and during the reporting period (a). Some of the area under CM in the base year is no longer under CM in the reporting year (b). There are also areas under CM in the reporting year that were not under CM in the base year (c). Area (D) is under CM, but was subject to Deforestation (D) which takes precedence. Area (e) has been converted to cropland, but remains under FM under the CEFC provision. Under the KP, the emissions and removals in areas (a) + (b) in the base year are compared to emissions and removals in areas (a) + (c) – (D) – (e) in the reporting year.

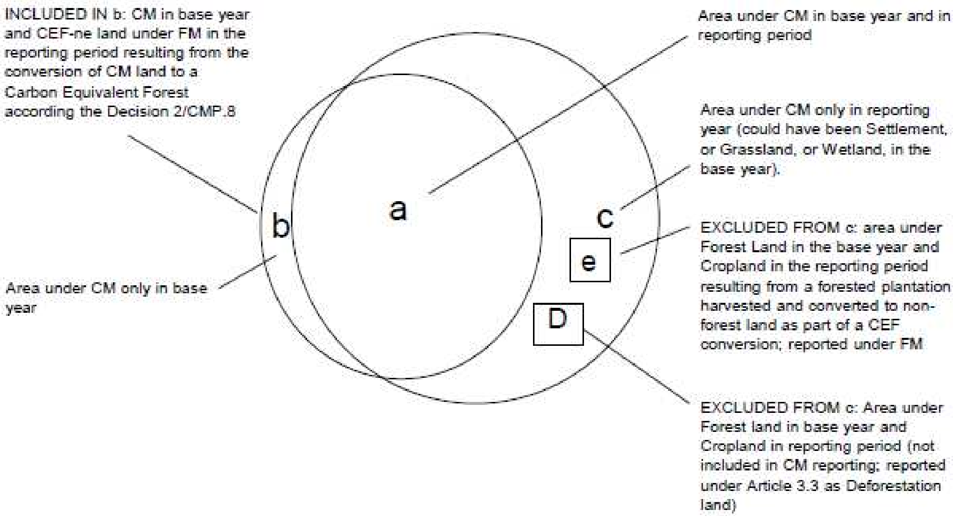

Figure 9 - Challenges of land tracking for LULUCF accounting in KP2 (KP suppl. GPG-LULUCF, 2013)

2.5. Summary: Upgraded LULUCF accounting rules to be considered

Since the start of the Kyoto Protocol, the forest sector has been more prominent in the LULUCF accounting rules than the agriculture sector (NB: carbon stock changes in agriculture soils considered under the "LULUCF" part of the greenhouse inventory, while CH4 and N2O emissions are considered under the "Agriculture" part). It presents great mitigation potentials: avoided deforestation and degradation, sustainable forest management, afforestation/reforestation, substitution of fossil fuel, carbon storage in wood products, and substitution of "grey energy" in building and housing materials…

However, this mitigation potential was poorly realised till now, due to technical constraints related to the specific nature of LULUCF: high inter/intra-annual variability of forest growth and loss, vulnerability and non-permanence of forest carbon, non additionnality of a certain part of the carbon sequestration.

There were also some political concerns at the time the Kyoto Protocol was designed: lack of scientific knowledge and consensus on forest sinks, fear of dilution of efforts, inverted agenda between the creation of the LULUCF (in Kyoto, 1997) and the setting of the precise LULUCF accounting rules (in Marrakech, 2001).

The initial LULUCF accounting rules – in use for the first commitment period, from 2008 to 2012 - were set in the Articles 3.3 and 3.4 of the Kyoto Protocol, and further detailed in the Marrakech Accords in 2001. These LULUCF accounting rules were upgraded in the recent climate talks (Cancun in 2010, Durban in 2011, and Doha in 2012) and will be used by Annex 1 Parties with binding commitments for the second commitment period, from 2013 to 2020.

The main features of these upgraded rules are as follow: (i) accounting for afforestation/reforestation and deforestation under Art. 3.3 is still mandatory (and "gross-net"), (ii) accounting for forest management under Art. 3.4 is now mandatory (and "gross-net" with cap of 3.5% of the 1990 total greenhouse gas emissions excluding LULUCF), (iii) accounting for cropland management, grassland management, revegetation under Art. 3.4 is still voluntary (and "net-net"), (iv) a new activity appears under Art. 3.4: wetland drainage and rewetting (voluntary and "net-net").

For the specific case of Art. 3.4 forest management: accounting for carbon storage in harvested wood products is now possible; emissions dues to natural disturbances can be discounted, following specific guidelines.

The accounting of forest greenhouse gases emissions and removals under the Kyoto Protocol are based on the same reporting requirements than under the Climate Convention: (i) estimating activity data and emissions factor for different carbon pools (living biomass, dead organic matter, soil organic carbon), (ii) respecting the principles of transparency, accuracy, precision, completeness, comparability, and consistency, (iii) using adequate Tier and Approaches, according to a Key category analysis. However, LULUCF accounting presents specific challenges, especially related to the tracking of land use changes according to the activities defined in Articles 3.3 and 3.4 of the Kyoto Protocol.

3. LULUCF in Turkey

3.1. Current key facts and figures about forests in Turkey

➔ Institutional context

The Ministry of Forestry and Water Works (MFWW) represents the highest authority in Forestry in Turkey. It is primarily responsible for reforestation, erosion control, range improvement, seedling production, protected areas, national parks, wildlife, forest villages and research works. It has three General Directorates (GDs) on Forestry, with the following tasks and responsibilities:

- GD for Forestry (OGM) is the main unit for the forest management. It has 27 Regional Directorates and 217 District Directorates at the field level;
- GD for Desertification and Erosion Control (CEM) has the primary responsibility to combat desertification and erosion of all classes of land, particularly eroded or degraded areas;
- GD for Nature Conservation and National Parks (DKMPGM)) has been involved in the protection and conservation of Turkey's forests and their wildlife.

Forest research is under the responsibility of the Ministry's Department of International Relations, Training and Research Unit, which comprises eight Provincial Research Institutes.

OGM is responsible for the management of 21.7 Mha of "forest land" or about 27% of the land area of Turkey, but only about 53% of what is designated as "productive" forests while the remaining 47% is made up of "degraded" or "unproductive" forests. Besides these areas, sizeable areas such as rangelands in or around forests, shrub lands, maquis, open alpine lands etc. are considered as part of the forest resources on technical grounds, which corresponds more than 40% of the country. These resources are mainly located in mountainous areas (HAASE – FAO, 2011).

➔ National vs FAO definition of "forest"

According to the Forest Law n°6831, the national definition of forest is the following: "*All natural woody and shrub areas and all plantations are accepted as forest. But, reed fields; steppes; bramble patches; parks; woody and shrub areas in cemeteries; areas which are in private ownership and covered with exotic tree species […] all the woody areas having less than three ha, all fruit tree and shrub areas […] including alder trees, chestnut trees, stone pine trees and Turkish oak trees; olive groves, pistachio trees, mastic, and carob trees; scrubs and maquis are not accepted as forests*" (OGM, 1956)

Six-subcategories of forest are then identified by the OGM: (i) coniferous (around 76% of the area of pure high forest) vs deciduous forest (around 24%), (ii) productive (more than 10% forest cover. 53% of the total forest area) vs degraded (between 1% and 10% forest cover. 47% of the total forest area), (iii) high forests (80% of the total forest area) vs coppices (20%). Below are presented the areas:

	Pure high forest		Mixed high	Total high			
	Coniferous	Deciduous	forest	forest	Coppices	Total	%
Productive	6 792 336	2 156 746	1 332 646	10 281 728	1 276 940	11 558 668	53%
Degraded	4 983 059	950 319	1 045 486	6 978 864	3 140 602	10 119 466	47%
Total	11 775 395	3 107 065	2 378 132	17 260 592	4 417 542	21 678 134	

Table 3 - Shares of productive vs degraded, coniferous vs deciduous, high forests vs coppices (OGM, 2012)

There are several concerns about the national definition of forest:

- Inclusion (or not) of "unmanaged forests"? According to OGM, "*Public forests represent 99.9% of the forests and 100% of the Turkish forests are managed*" (OGM, 2012). 1 400 management plans are currently carried out (duration of 10 to 20 years) on productive forests and 10 272 000 ha of this area under management would be revised by 2020, for a moderate cost, i.e. 5.42 TL/ha to 28 TL/ha. 55 "conservation forests" (251 409 ha) are also considered as "managed" forests by OGM (pers. com. Mehmet CEYLAN - Forest Management and Planning Department of OGM, February 2014).

But, at the same time, protected areas, under the responsibility of the General Directorate of Nature Conservation and National Parks of the MFWW, are considered as “unmanaged” by OGM (*Ibid*), which highlights an issue about the common understanding of “managed” vs “unmanaged” and a possible overlapping of these definitions with “degraded” vs “productive” ones.

Various reports also mention the existence of “unmanaged forest”: (i) “*4.1 Mha of the total forests (19 %) consisting of national parks, protected areas, and other kinds of abandonment areas which were separated as unmanaged (out of felling) forests due to some conservative considerations*” (TurkStat quoted in National GHG Inventory Report - NIR, 2006), (ii) 0,9 Mha of “Primary Forests” (reported under the national classes 2.1 to 2.15) in the FAO FRA 2010 (FAO, 2010), (iii) 2,2 Mha of “*Protected areas, that include 41 national parks (898 044 ha), 39 nature parks (79 928 ha), 31 nature reserves (46 575 ha), 79 wildlife reserves (1 201 032 ha) and 106 natural monuments (4 323 ha)*” (HAASE – FAO, 2011). In total, these “unmanaged” or “non-commercial” forests could encompass 0.9 Mha, or 2.2 Mha, or even 4.1 Mha…It has some consequence on the GHG inventory (see **Parts 3.2 and 3.3 infra**);

- Coherence between the “legal boundary” (cadastre) and the “technical boundary” (management plan”)?: “*When cadastre and boundary marking activities are completed, in the size of legal forest areas is estimated to be crucial increments [...] For example, forest area where cadastral studies completed like İstanbul and Tekirdağ shows a 10-40% increase in comparison with the forest area given in the management plans*” (National Forest Programme - NFP, 2003).

  The cadastre deployment is still on-going and the boundaries of forest management plans are revised accordingly when they are renewed (every 10 to 20 years) (com. pers. Selda PAS - GIS Division of Information System Department of OGM, February 2014). Knowing that the forest areas are regularly monitored using the forest management plans (compiled in the Forest Inventory and Statistical Database - ENVANIS) and that these areas are used in the GHG inventory, it has also some consequences on the latter (see **Parts 3.2 and 3.3 infra**);

- Consideration of private afforestation?: “*Afforestation and agro-forestry activities with poplar, salix, acacia and eucalyptus species in private lands, boundary of cultivated lands and along the creeks by villagers and farmers are in an important level. These plantations are generally outside the forest regime and their annual timber production is estimated to be some 3.5 Mm3. […] Annual production from private sector poplar plantations and fast growing species afforestation is more than 3,3 Mm3*” (NFP, 2003).

  Considering the lower value (3.3 Mm3/yr) and a conservative assumption of volume increment (Iv) of 10 m3/ha/yr for these fast growing species, private plantations would cover at least 0.33 Mha of land in 2003. However, an assumption of 20 m3/ha/yr and 0.17 Mha in 2003 may also be considered more realistic (pers. com. Dr. Yusuf SERENGIL – Istanbul University, March 2014).The reported values for private afforestation are 24 237 ha in 2000 and 311 056 ha in 2007 (FAO FRA 2010). This last value might better fit to the reality. As it does not appear clearly how these private plantations (poplar plantations on the one hand, considered as agriculture land in Turkey and reported as CL-CL; other private plantations on the other hand, considered as forest land in Turkey) were taken into account in the GHG inventory, it has also some consequences on the latter (see **Parts 3.2 and 3.3 infra**);

In addition to the problems attached to the national definition of forest (Managed vs unmanaged forest? Legal vs technical boundary? Private afforestation?), there is a major problem of inconsistency between the national definition and the FAO definition.

Indeed, the FAO definition of forest is the following: area > 0,5 ha; tree > 5 m; canopy cover > 10%; no inclusion of land predominantly under agricultural or urban land use. Furthermore, it is good practice to use this FAO definition to report GHG emissions/removals under the UNFCCC (IPCC, 2003). Last, but not the least, it is good practice to use this FAO definition as a basis to set up the country-specific definition of forest under the KP (see **Part 2.2 supra**): area > 0.05 to 1 ha; tree > 5 m; cover > 10% to 30%; possibility to include land predominantly under agricultural land use.

The use of the national definition instead of the FAO definition (in existence) or a KP definition (theoretical, since Turkey did not submit its Initial report to the KP) has two opposite consequences: (i) since forest area < 3 ha are not considered, it underestimates forest area, (ii) since forest with cover > 1% are considered, it overestimates forest area. We will come back to this issue (see **Part 3.4 infra**).

➔ Historical changes in forest area

Two National Forest Inventories (NFI) were carried out in 1972 and 2004. Between these dates, the forest area increased by 0.99 Mha, i.e. +0.15%/yr. After 2004, ENVANIS was created: based on full forest cover type mapping through 1/25,000 infrared aerial photos and a systematic sampling grid (300 m by 300 m) of circular plots, whose sizes range from 400 m² to 800 m², depending on crown cover. It compiles data from forest management units and classifies stands with three criteria: species mix, crown closure and age classes. Therefore, it allows the calculation of area changes, volume increment changes, and stock changes year by year.

It is possible to draw an historical data series of “forest area” (in line with the national definition), using FAO FRA 2010 data for the years 1972 (NFI carried out by OGM), 1996 (partial NFI carried out by OGM), 1999 (report on “Forests and Turkish Forestry” by Mr. KONUKCU), 2004 (NFI carried out by OGM), and 2004 to 2010 (ENVANIS data compiled by the OGM) and adding areas of the following land uses:

- Forest Land (FL): Area > 0,5 ha; Tree > 5 m; Tree canopy cover > 10%; No inclusion of land predominantly under agricultural or urban land use. This FAO definition of FL is equivalent to the national definition of “productive forest” (which can be high forest or coppice);
- Other Wooded Land (OWL): Land not classified as forest; Area > 0.5 ha; Tree > 5 m; 5% > Tree canopy cover > 10%, or combined cover of shrubs, bushes, and trees > 10%; No inclusion of land predominantly under agricultural or urban land use. This FAO definition of OWL is partially equivalent to the national definition of “degraded forest” (which can be high forest or coppice): as the definition of degraded forest captures land with 1% to 10% of tree cover, the area of degraded forest is bigger than the area of OWL (with tree cover between 5% to 10%).

Estimate for 1973 to 1995 was possible through linear interpolation of the data for 1972 and 1996. Estimate for 1997 to 2003 was possible through linear interpolation of the data for 1996 and 2004. Below are presented the changes in FL and OWL areas from 1972 to 2010 (see detailed data in **Excel sheet FL FAO**):

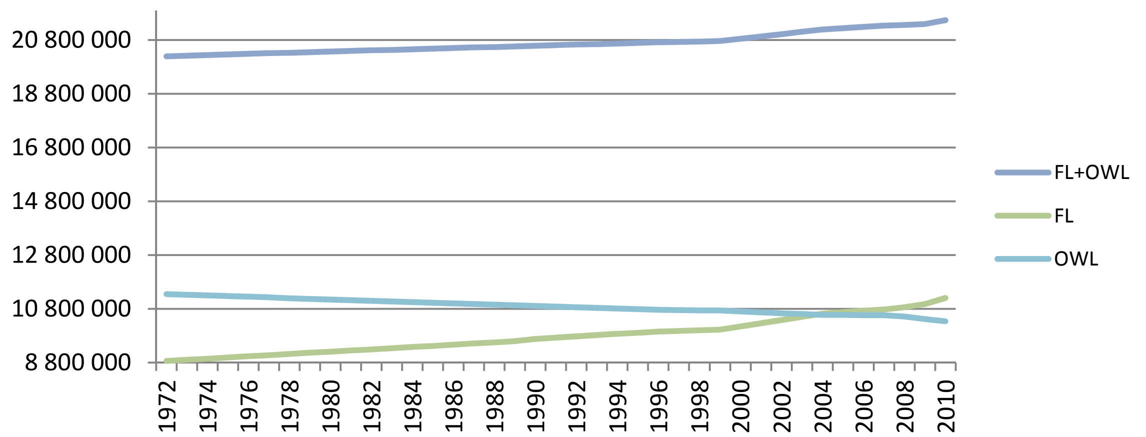

Figure 10 - Changes in FL and OWL areas (ha), 1972-2020 (BOUYER, 2014 – based on FAO FRA 2010)

It is important to note that (i) the total forest area (FL+OWL) increased by 1.34 Mha from 1972 to 2010, (ii) the FL area increased from 1972 to 2010, meanwhile OWL area decreased. Assuming a theoretical linear trend, the FL area would be 11.8 Mha by 2020 (compared to 8.9 Mha in 1972) and the OWL area would be 10.1 Mha by 2020 (compared to 11.3 Mha in 1972). In average, for 1990-2010, FL increased by 76 161 ha/yr (conversion of OWL and other land uses to FL by regeneration + plantations).

Focusing on forest area changes from 2004 to 2011, using ENVANIS data, it is important to note that (i) the area of coppices is decreasing and area of high forests is increasing, (ii) the area of degraded forest is decreasing and area of productive forest is increasing. Below are presented these changes (see detailed data in **Excel sheet FL OGM**):

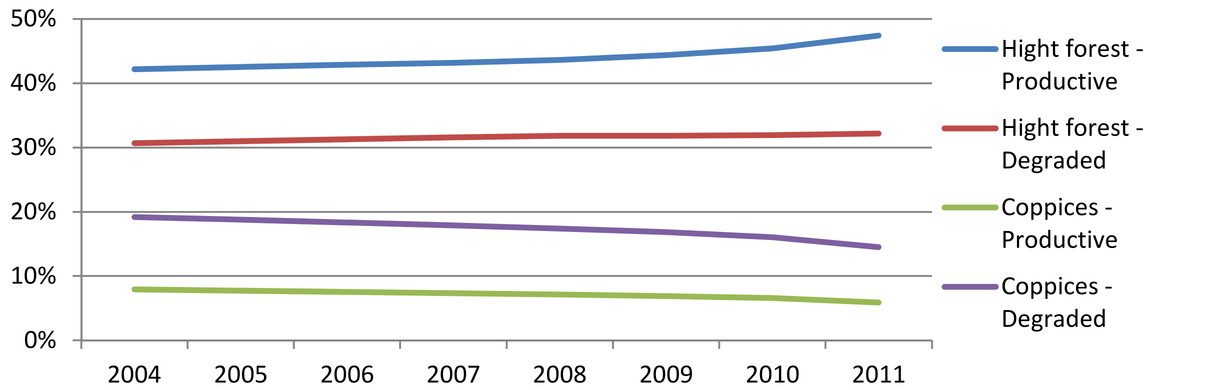

Figure 11 - Area changes (%): high forest vs coppices, productive vs degraded, from 2004 to 2011 (OGM, 2012)

➔ Historical rates of Afforestation and Reforestation (AR)

In the FAO FRA 2010, various types of AR are considered and only a certain % of each area is finally reported: 100% for artificial regeneration, 80% for public afforestation, 40% for rehabilitation and erosion control, 20% for energy forest, and 10% of private afforestation. This "reclassification", based on expert judgement, aims at taking into account three facts (com. pers. Yucel FIRAT – General Directorate of Desertification and Erosion Control and former Lead Author for the FAO FRA 2010 report for Turkey):

- Some activities are reported for a given perimeter, but only part of it is effectively reforested: hedges, small patches, etc.
- The rate of survivals depends on the type of plantations carried out, itself depending on the natural conditions, sometimes very difficult in Turkey: poor rainfalls, degraded soils, etc.
- In the specific case of private afforestation, the reclassification rate is extremely low (10%), since trees are assumed to be planted in linear alignment, small patches, hedges, etc. and therefore private afforestation is assumed to be done mainly on agricultural land.

OGM data series (compiling data from OGM, and AGM, but also other public services and AR made by the private sector) are available since 1947 and use the same categories as the ones used in FAO FRA 2010 apart for two categories: (i) "artificial regeneration" is reported under "afforestation" by OGM, (ii) "range improvement" is used by OGM, but does not exist in the FAO categories: areas under range improvement are reported under "erosion control" in FAO FRA 2010.

This being said, the two set of "reclassified" data series are consistent: if "raw" AR is 198 774 ha/yr over 1990-2013 for OGM and 174 014 ha/yr over 1990-2010 for FAO, "reclassified" AR is 87 512 ha/yr over 1990-2013 for OGM and 81 996 ha/yr over 1990-2010 for FAO. There is only a bit less of 7% difference between the two data series, in favour of OGM. But, knowing that OGM data series are complete over time and documented by various archives, these data series are used in our calculations. Below are represented the reclassified AR, using two different scales: right one for rehabilitation, and left one for the other types of AR (see detailed data in **Excel sheet AR OGM**):

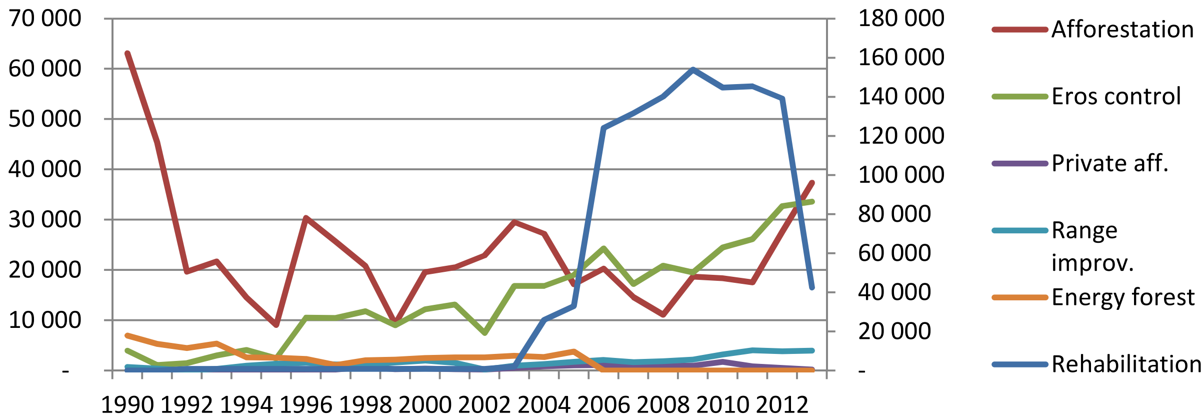

Figure 12 - Changes in AR (ha/yr) from 1990 to 2013 (BOUYER, 2014 – based on OGM, 2014)

"*According to a survey carried out by AGM in 1999-2000, potential areas for afforestation, erosion control and range improvement are respectively 2.4 Mha, 1.4 Mha, and 0.8 Mha. (total 4.6 Mha)*" (NFP, 2003). From 2000 to 2013, according to quoted (and reclassified) data from OGM 2014, around 0.617 Mha have been covered by the mentioned activities. It means that around 4 Mha may still be covered by the mentioned activities.

NB: Areas of "other land with tree cover" (land not classified as FL or OWL; Area > 0.5 ha; Tree > 5 m; Tree canopy cover > 10%. Mainly fruit trees and olive trees in Turkey) are mentioned for years 1990, 2000, 2005, 2006, 2007, 2008, 2008, and 2010 in the FAO FRA 2010. However, (i) it is mentioned that areas of fruit trees and olive trees were only recorded for three years 2000, 2005, and 2010 by TurkStat, and, furthermore, (ii) the national definition of forest excludes these fruit trees. For these reasons, in the rest of the study, these fruit trees will not be considered in the forest sink assessments.

➔ Historic data for Stock (S) and Volume Increment (Iv)

An NFI was carried out in 1972 and 2004. After 2004, annual estimates were produced with ENVANIS. In 2012, the situation was as follows:

2012	Stand type	High forest	High forest	High forest	High forest	Coppices	All
(OGM, 2012)	Main species	Coniferous	Deciduous	Mixed	All	All	All
Area (ha)	Productive	6 792 336	2 156 746	1 332 646	10 281 728	1 276 940	11 558 668
	Degraded	4 983 059	950 319	1 045 486	6 978 864	3 140 602	10 119 466
	Total	11 775 395	3 107 065	2 378 132	17 260 592	4 417 542	21 678 134
Total S (m3)	Productive	825 750 787	313 485 436	225 950 016	1 365 186 239	52 296 445	1 417 482 684
	Degraded	41 541 895	8 342 796	9 435 004	59 319 695	17 652 159	76 971 854
	Total	867 292 682	321 828 232	235 385 020	1 424 505 934	69 948 604	1 494 454 538
S (m3/ha)	Productive	121,6	145,4	169,5	132,8	41,0	122,6
	Degraded	8,3	8,8	9,0	8,5	5,6	7,6
	Total	73,65	103,58	98,98	82,53	15,83	68,94
Total Iv (m3/yr)	Productive	22 937 367	8 616 137	5 747 210	37 300 714	2 719 466	40 020 180
	Degraded	1 003 235	196 433	211 972	1 411 640	747 296	2 158 936
	Total	23 940 602	8 812 570	5 959 182	38 712 354	3 466 762	42 179 116
Iv (m3/yr/ha)	Productive	3,4	4,0	4,3	3,6	2,1	3,5
	Degraded	0,2	0,2	0,2	0,2	0,2	0,2
	Total	2,03	2,84	2,51	2,24	0,78	1,95

Table 4 - Stocks (S) and volume increments (Iv) in 2012 for different forest types (OGM, 2012)

According to OGM (OGM, 2012), degraded forests are marginal in terms of:

- Stock (S): a bit more than 5% of the total S, i.e. 7.6 m3/ha for degraded forests in average, compared to 122.6 m3/ha for productive forests in average;
- Volume Increment (Iv): a bit more than 5% of the total Iv, i.e. 0.2 m3/ha/yr for degraded forests in average, compared to 3.5 m3/ha/yr for productive forests in average.

Between 1972 and 2004, areas and stocks of the coppices reduced (mainly in degraded coppices) while those of high forests increased. The explanations for such changes are (FAO FRA 2010): rural exodus, abandonment of "*old fashion goat breeding and cattle grazing in the forests and the meadows adjacent to forests*", abandonment of some forest on steep slopes, promotion of multi-functional use of forest resources, conversion of coppices into high forests, afforestation activities on the bare lands and degraded forests (especially with the National Afforestation and Erosion Control Action Plan).

Additional measures on logging are also mentioned (UNDP, 2011): "*in the period 2007-2008: introduction of controls on logging […] Large-scale deforestation ended in the late 1990s when the Government placed a ban on clear-cut industrial logging*".

As for Iv, below are presented all the calculated Iv, in 1972 and then from 2004 to 2011, disaggregated for productive vs degraded forests, and high forest vs coppices:

Iv	High forest	High forest	Coppices	Coppices	All	All	All
(m3/ha/yr)	Productive	Degraded	Productive	Degraded	Productive	Degraded	All
1972	3,37	0,28	1,80	0,17	2,89	0,22	1,39
2004	3,35	0,23	2,34	0,23	3,19	0,23	1,71
2005	3,36	0,23	2,31	0,23	3,20	0,23	1,72
2006	3,41	0,22	2,28	0,23	3,24	0,23	1,75
2007	3,42	0,22	2,25	0,23	3,25	0,23	1,75
2008	3,40	0,22	2,20	0,23	3,23	0,22	1,75
2009	3,47	0,22	2,20	0,23	3,30	0,22	1,80
2010	3,55	0,21	2,17	0,23	3,37	0,22	1,86
2011	3,63	0,20	2,13	0,24	3,46	0,21	1,95
Mean	3,44	0,23	2,19	0,22	3,24	0,22	1,74
St. dev (SD)	0,07	0,01	0,10	0,01	0,10	0,01	0,09
Mean-SD	3,37	0,21	2,08	0,21	3,14	0,22	1,65

Table 5 - Iv for prod. vs deg. forest, and high forest vs coppices (BOUYER, 2014, based on OGM, 1972; 2005-2012)

The values are quite stable over time for all types of forests. However, in the calculations made in this study (see **Parts 4.1 and 4.2 infra**), we will further refine these estimates, based on NFIs and ENVANIS results (see detailed data in **Excel sheet Iv NFI**):

➔ Climatic zone and forest soil types

The climatic zones of Turkey are as follow:

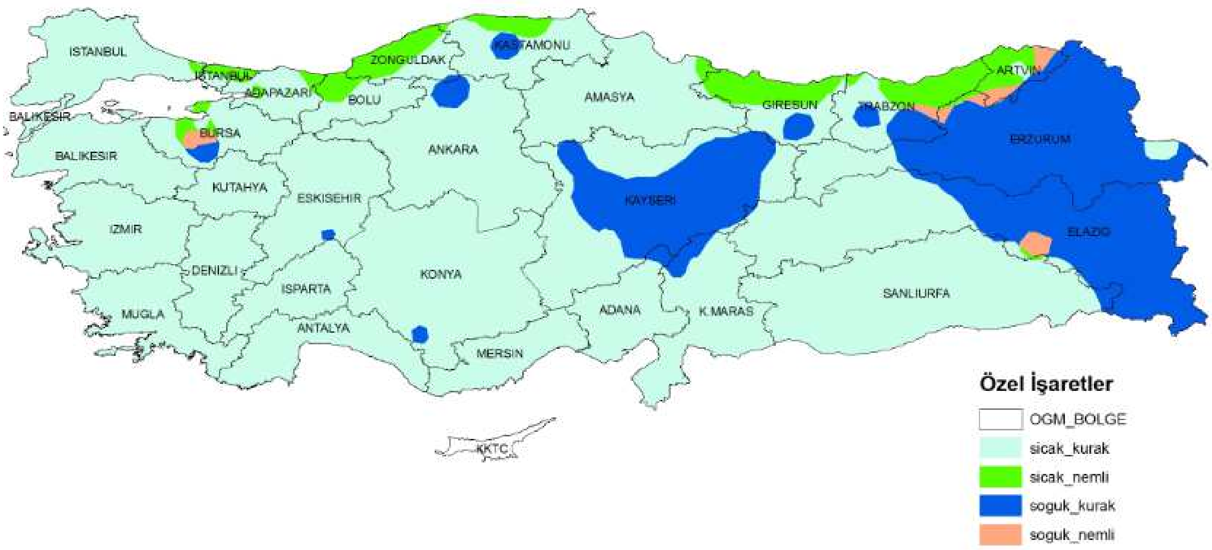

Figure 13 - Map of climatic zone of Turkey (OGM - GIS division, 2014)

NB: Sicak = hot, soguk = cold, kurak = dry, nemli = wet

As it can be seen, the climate is hot and dry in most part of the country, apart from the East where the presence of mountains explains the hot and dry weather. However, having this climate map is of limited use to refine estimates in terms of forest growth and biomass decay (and, consequently, carbon fluxes from and to the soil, the litter, and the deadwood in forest), since the national soil map (23 categories) is said to be not reliable, as most of samples were taken in non-wooded areas (pers. comm. from Mrs Selda PAS - GIS Division of the Information System Department of OGM, February 2014).

➔ Roundwood harvest in OGM-managed forests

As can be seen in the figure below, the harvest was high in the 70's (above 20 Mm3, made of firewood for roughly 75%). From there, it decreased to its lowest level at the beginning of the 2000's (12.5 Mm3/yr in 2001), before to rise 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 Mm3/yr), started to increase strongly after (see detailed data in **Excel sheet RW OGM**):

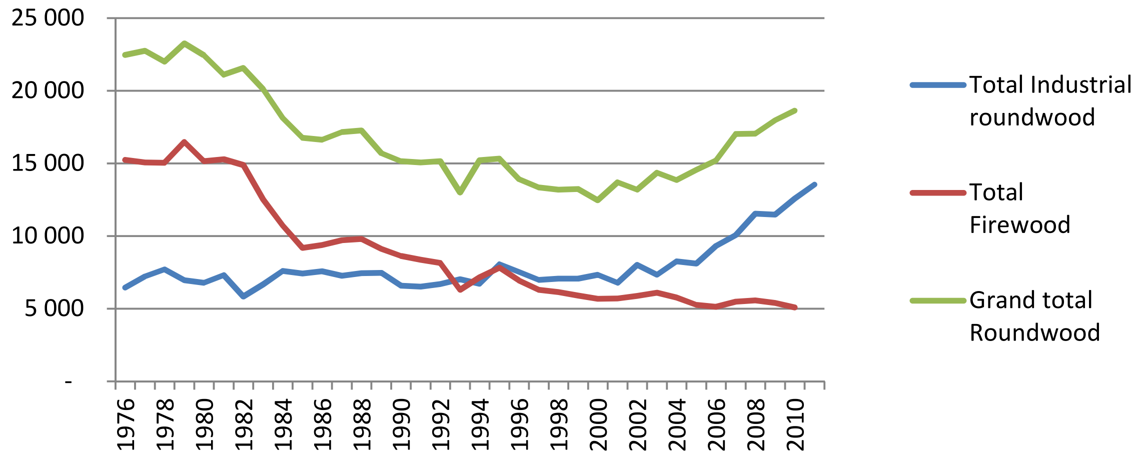

Figure 14 - Annual harvest (ind. roundwood and firewood) in '000 m3 from 1976 to 2011 (OGM, 2014)

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.

"*Firewood is assumed to be harvested only in productive forest and no harvesting of industrial roundwood is reported for degraded forests"* (NIR, 2013).

For 2007-2011, the average harvest was 17.2 Mm3 (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).

Wood products prices are quite stable for the last ten years (2004-2013), with average prices (constant price in TL) of 223 TL/m3 for coniferous logs, 217 TL/m3 for deciduous logs, 158 TL/m3 for small logs, 129 TL/m3 for pulp wood, 65 TL/m3 for fiber wood, and 55 TL/m3 for firewood. In total, the weighted average for all types of products over the last ten years (i.e. taking into account their share of the total harvest) is 114 TL/m3. For industrial roundwood only, it is 142 TL/m3 (Ibid).

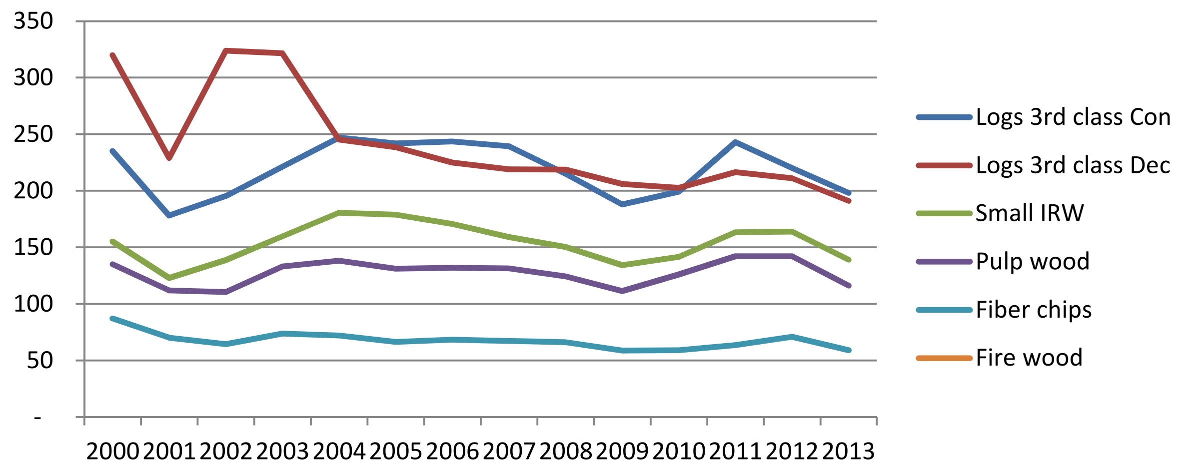

Figure 15 - Wood product prices in constant price (TL/m3) from 2000 to 2013 (OGM, 2014)

As it can be seen in the figure below (see detailed data in **Excel sheet Vfell-Ext OGM**), industrial roundwood is not only produced in OGM-managed forests, but also in private plantations, and is estimated to be around 3 to 3.5 Mm3/yr (expert judgment, since ENVANIS does not record this type of harvest), mostly composed of poplar, 2 to 2.5 Mm3/yr (pers. com. M. Ramazan BALI, Head of the Wood Marketing Division of OGM, February 2014)

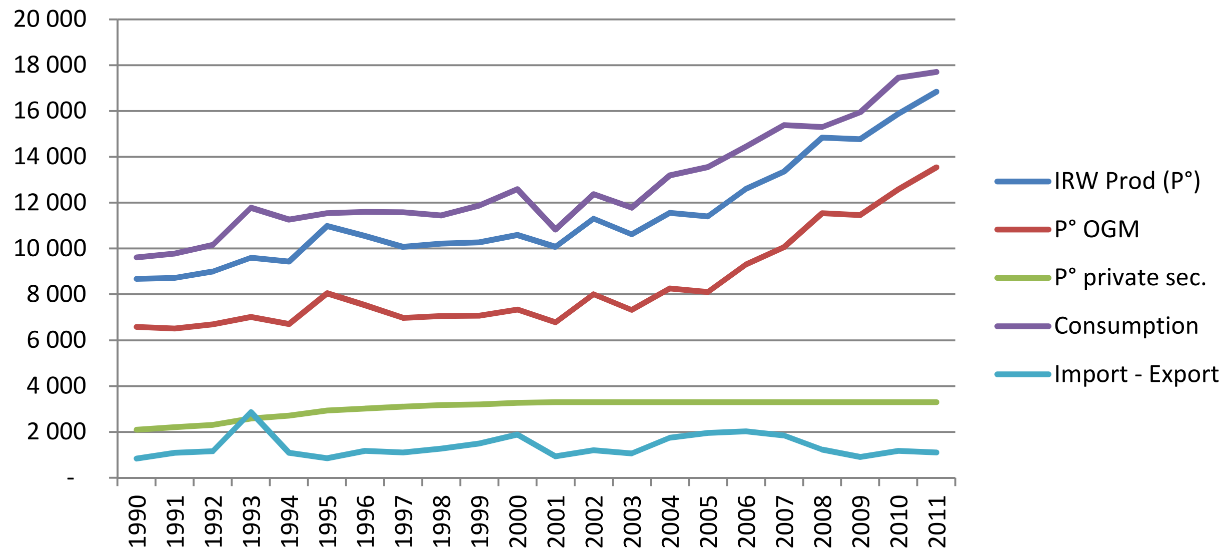

Figure 16 - Production, consumption, export and import of industrial round wood in '000 m3/yr (OGM, 2014)

Indeed, there might be more than 0.5 Mha of private afforestation in 2013: 466 696 ha reported for 2010, in FAO FRA 2010, including at least 125 000 ha of poplar (HAASE - FAO, 2008). Assuming that most of them are made of fast growing species like poplars or eucalyptus (FAO FRA 2010), with at least an Iv of 5 m3/ha/yr, it might effectively add at least 2.5 Mm3 to the OGM harvest.

As it can be seen in the figure below, roughly 50% of the production of firewood would come private plantations and illegal harvest. This last one covers both “completely” illegal harvest by the rural populations and “hidden” harvest by forest villagers (e.g. part of a forest cooperative, they are allowed to collect 5 sters of wood, but they would collect 10 sters).

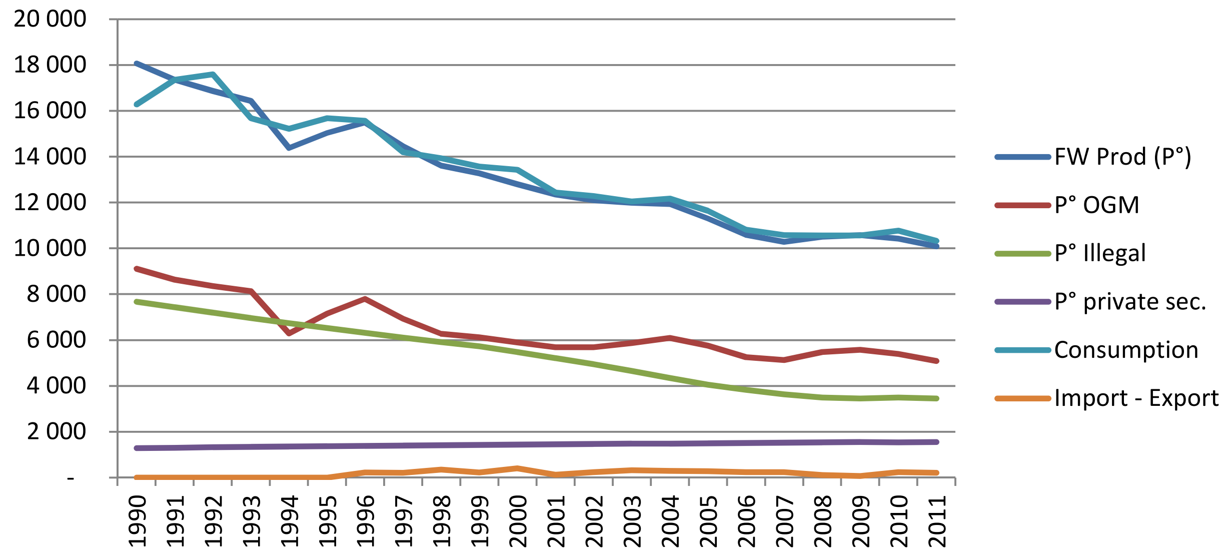

Figure 17 - Production, consumption, export and import of firewood in '000 m3/yr (Source: OGM, 2014)

This illegal harvest is identified for long: “*In spite of not having accurate data on the present quantity of illegal timber utilization which was estimated to be some 10 Mm3 in the past is expected to be some 5.5 Mm3*” (VIII, Five Year Development Plan, Forestry Special Task Commission Report, 2001); ”*The amounts received by legal ways are not sufficient to meet the needs. And the secret timber utilization of 4-5 Mm3 from the forests have been carried out illegally by the forest villagers*” (NFP, 2003)

However, completely illegal or hidden harvest, are not monitored by OGM, either by direct measurement in the forest or indirect measurements, via household survey. They were estimated in the 80’s (NB: we did not identify the study) and, since then, the volume of illegal + hidden harvest is reviewed by expert judgment (pers. com. M. Ramazan BALI - Head of the Wood Marketing Division of OGM, February 2014).

Statistics for firewood have to be considered cautiously, since alternative figures can be found in the literature, and show large differences with the OGM data. For instance:

- "*The share of biomass in total primary energy production was 23% in 2004. Most of this was in the form of wood with a share of 18%.Overall biomass potential is approximately 15 Mtoe of which 6 Mtoe is being used*" (first National Communication to the UNFCCC - NC1, 2007). Knowing that the total primary energy production was 23.4 Mtoe in 2007, the share of firewood in this total was 4.3 Mtoe (23.4 Mtoe x 18%);
- "*9% (9,95 Mtoe) of Turkey's total primary energy supply in 2009 came from renewable energy resources […] 47% of renewable energy resources in Turkey came from biomass […] and in contrast with the global trend, the use of biomass is decreasing*" (NCCAP, 2011).

Using this last estimate as a starting point, the production of firewood was estimated at 4.67 Mtoe (9.95 Mtoe x 47%) in 2009. Further assuming that (i) 100% of the biomass is made of firewood, (ii) 100% of this firewood is coming from productive forest, (iii) 1 toe = 2.2 tons of dry matter (tdm) of wood, woody biomass harvest in productive forests was estimated at 10.29 Mtdm in 2009. Using:

- The shares of forest types in productive forests: 59% of coniferous high forests, 19% of deciduous high forest, and 23% of mixed forests (mixed high forests and coppices) (OGM, 2012);
- The default values for the Biomass Conversion and Expansion Factor (BCEF), extracted from Table 5.4 of the FAO FRA 2010 Guidelines: 1.33 m3/tdm for coniferous, 0.95 m3/tdm for deciduous, and assuming the BCEF for mixed forests is an average of the two, i.e. 1.14 m3/tdm;

Then, firewood harvest in 2009 can be estimated in the different forest types: 8.07 Mm3 (10.29 Mtdm x 59% x 1.33 tdm/m3) in coniferous forests; 1.86 Mm3 (10.29 Mtdm x 19% x 0.95 tdm/m3) in deciduous forests; 2.70 Mm3 (10.29 Mtdm x 23% x 1.14 tdm/m3) in mixed forests; 12.62 Mm3/yr in 2009…i.e. 2 Mm3/yr more than the OGM estimate for the same year: 10.57 Mm3/yr, according to the statistics from the Wood Marketing Division of OGM. We will come back to these issues in further details (see **Part 3.4 infra**).

➔ Forest fires

"*With the semi-arid conditions found in much of the country, forest fires are a major threat. Most of the forest fires in Turkey occur between June and October: the majority of them are the result of human activities. Most are caused by human negligence or carelessness though a significant number are caused by intentional human interventions (clearing for agricultural land and settlement areas). OGM has developed a nation-wide forest fire management system*". (HAASE – FAO, 2011)

"*The coastal belt, which extends from Antakya to Istanbul in the North is regarded to be the region most at risk from fires, and nearly 12 Mha of forests in the area are vulnerable. The majority of forest fires are human induced, less than 2% being attributable to natural factors […]. About 40% of these are high intensity crown fires that destroy most of the biomass; 60% are ground-fires whereby about 55% of the biomass is destroyed […] The annual frequency of fires has increased since 2004 and is expected to increase further as a consequence of climate change*" (UNDP, 2011)

Below are presented the historical data regarding forest fires (extracted from the forest fires database of the Forest Fire Department of OGM). NB: It is worth to note that, since the fire monitoring system was changed in 2005 and allowed for a better recording of forest fire, data before 2005 may be underestimated (pers. comm. Ugur BATTACI - Meteorology Division of Forest Fire Department of OGM, February 2014). See detailed data in **Excel sheets Fire FAO and Fire 3.3 & 3.4**:

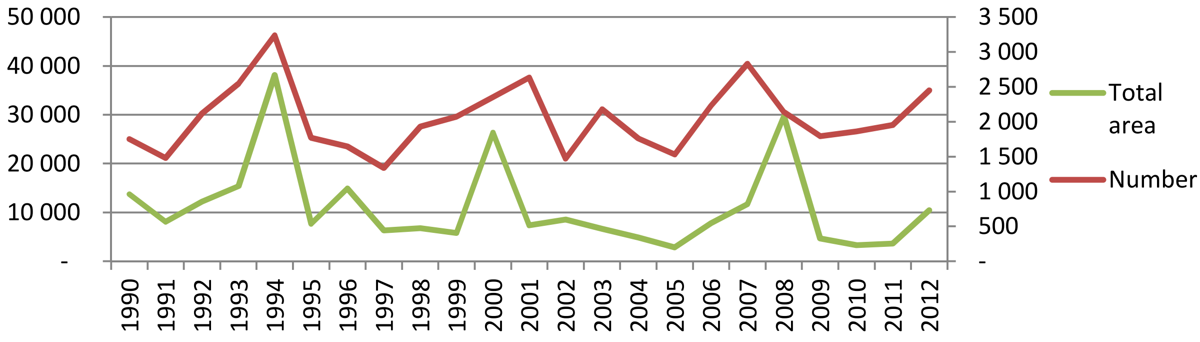

Figure 18 - Number of fires and area per fire (ha) from 1990 to 2012 (OGM, 2014)

There are high levels of variability for number of fires and area per fire. If we consider the averages of burnt area, number of fires, and area per fire for the periods 1990/2000 and 2000/2012, and if we compare them, we can identify a decreasing trend in terms of burnt area (-390 ha/yr), area per fire (-0.4 ha/yr), and number of fires (-6.2 fires/yr):

	Area (ha)	Number	Area (ha/fire)
Average 1990/2000	14 128	2 022	6,6
Average 2000/2012	9 834	2 090	4,6
Change 90/00 vs 00/12	-4 294	68	-3,9
Annual change*	-390	6,2	-0,4
*Over 11 years, using 1995 as the "central" year for the 90/00 period and 06 as the "central" year for the 00/12 period			

Table 6 - Changes 90/00 vs 00/12: burnt area (ha), number of fires and area (ha) per fire (OGM, 2014)

As most of the fires are illegal, scattered over a huge territory, and therefore difficult to control, it seems reasonable to assume that the number of fire will further increase according to the fast changing natural conditions: "*One of the most important effects of climate change is the recent and possible future increase in the intensity, duration and extent of forest fires in Turkey. As a natural result of the Mediterranean climate, hot and dry summers are dominant across Turkey, except for the Black Sea Region and Northeast Anatolia. When decreasing trends of precipitation since the early 1970s are taken into account, like hot and dry summers in 2007 and 2008 in many regions, the increased probability and severity of forest fires is likely to be an important problem.*" (NC5, 2013)

In 2013, 3 755 fires and 11 456 ha of burnt area were recorded, giving an average of 3.05 ha/fire. 27.8% were ground fires (mainly on Pinus brutia, with few damages) and 72.2% were crown fires (with big damages, especially for coniferous forests, that do not reshoot) (pers. comm. Ugur BATTACI - Meteorology Division of Forest fire Department of OGM, February 2014).

In 2013, 110 MTL of special budget and 75 MTL of revolving fund were spent to fight against forest fire, totalling 185 MTL, not included the human resources (information sent by email by the Forest fire Department, February 2014).

NB: Fires on agriculture land are not considered in the study, since they do not impact forest carbon changes.

➔ Other biotic and abiotic damages (apart from forest fires)

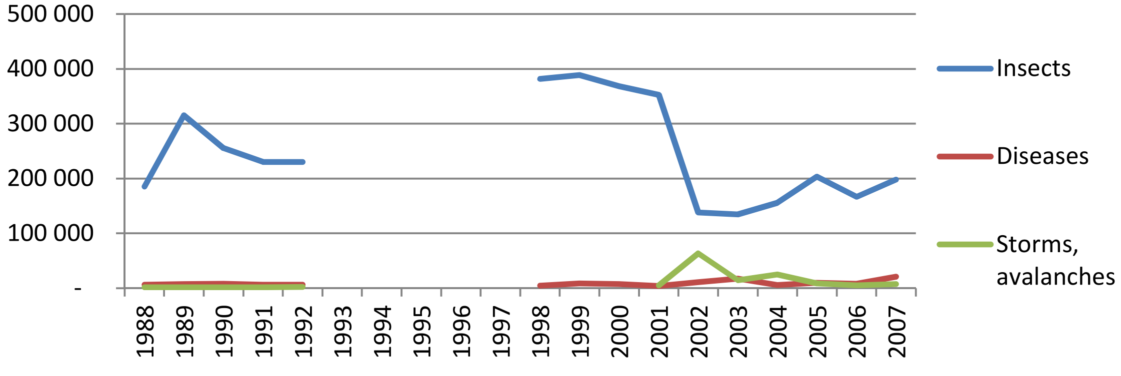

Figure 19 - Forest area (ha) affected by insects, diseases, storms/avalanches (FAO FRA, 2010)

As can be seen in the figure above, the main problems seem to be insects outbreak. The two majors insects outbreaks, in terms of affected areas, were (i) Thaumetopoea pityocampa (Schiff.), which spread over 2 204 000 ha of Pinus brutia ten and Pinus nigra Arnold between 1997 and 2001, (ii) Dendroctonus micans (Kug.) which spread over 990 000 ha of Picea orientalis (L.) between 1996 and 2001 (FAO FRA, 2010). Diseases appear marginal, as well as abiotic factors (See detailed data in **Excel sheet Disturb FAO**).

However, recent figures are different: from 2008 to 2012, it is estimated that 880 704 ha (roughly 7 350 000 m3) of coniferous + 149 020 ha (roughly 1 045 000 m3) of deciduous were destroyed by abiotic factors (snow, avalanche, drought, wind, flooding), totalling 1 029 723 ha (roughly 8 395 000 m3). In average, over the period: roughly 206 000 ha/yr and 1.68 Mm3/yr (information sent by email by the Forest Pest Control Division of OGM, February 2014).

Abiotic and biotic damages (excluding fire) have to be relativized, since most of the affected areas are subject to salvage logging and the wood incorporated in the harvest from OGM (pers. comm. Caglar BASSULU – Foreign Relations, Training, and Research Department of OGM, February 2014).

Since 2002, OGM has been promoting the biological control of forest pests (e.g. in 2013: transfer of 61 125 bird nests and 130 ant colonies, and dissemination of more than 50 000 insects). However, pests started to increase, because of climate change. Therefore, in 2006, the project "Monitoring of forest health" was launched and is still on-going since: at level 1, 818 permanent plots set up (but only 603 monitored between 2007 and 2013); at level 2, 50 permanent plots set up (first monitoring foreseen in 2014); in addition to that, 13 automatic meteo-observatories were also set up.

In the meantime, biological, mechanical, chemical, and biotechnical pests control practices were promoted, with an increased budget (left axis), that allowed decreasing the affected areas (right axis), as can be seen below (See detailed data in **Excel sheet Pests OGM**):

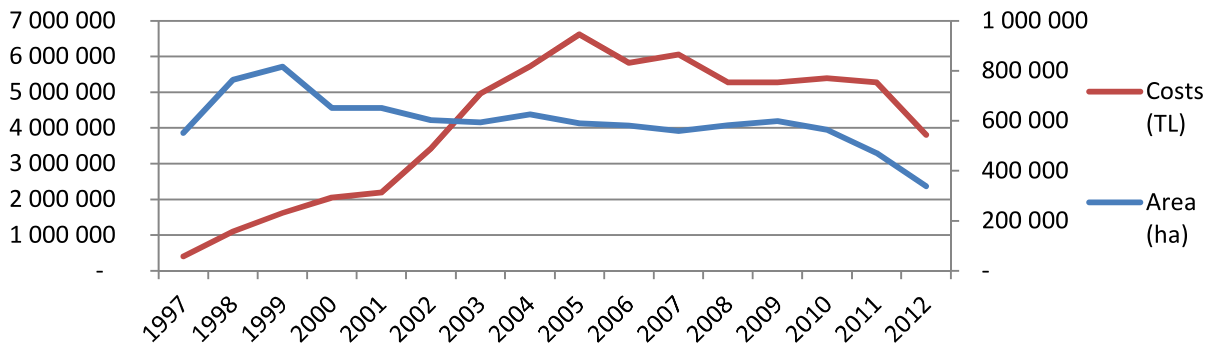

Figure 20 - Costs and areas related to forest pests control (OGM, 2014)

NB: the positive and negative impacts of climate change on the Turkish forests are not taken into account in this study, since there is no quantified data about it (to our best knowledge)

3.2. Assumptions, methodologies, data & trends in LULUCF GHG inventories

Information contained in this Part 3.2 and the following, Part 3.3, are sourced from:

- The Turkish National Inventory Reports (NIR) on LULUCF for years 2006 (no NIR before that), 2007, 2009 (no NIR in 2008), 2010 and 2011 (the last published);
- The Common Reporting Format (CRF) tables 1990-2011 submitted to the UNFCCC;
- The first National Communication (NC) of Turkey to the UNFCCC (submitted in January 2007) and the second NC (submitted in December 2013). NB: Most of the 41 Annex 1 Parties submitted their first NC in 1994 or 1995, the second in 1997 or 1998, the third after November 2001. The fourth NCs were due on January 2006, the fifth NCs on January 2010, and the sixth NCs on January 2014. As Turkey ratified the UNFCCC in 2004, its first NC came along the fourth NCs of most of the other Annex 1 Parties, and its second NC came along the fifth NCs, reason why the second NC for Turkey is also referred to as the fifth NC.

Turkey ratified the KP in 2009 but does not have a binding commitment under Annex B to the KP. Therefore, Turkey did not submit its “Initial report” to the KP (as provided for under the Art. 7.4 of the KP). For these reasons, Turkey did not submit a “forest definition” under the KP, did not elect LULUCF activities under Art. 3.4 of the KP, and does not report and account GHG emissions/removals under the KP. In Part 3.2 and the following, Part 3.3, we therefore assess the UNFCCC GHG inventory.

➔ Overview

The Turkish Statistical Institute (TurkStat) is responsible for the national inventory as indicated in the Official Statistical Programme (Statistic Law #5429) and as stipulated by decision n°2009/1 of the inter-ministerial Coordination Board on Climate Change (CBCC).

The Ministry of Forestry and Water Works (MFWW) and the Ministry of Food, Agriculture and Livestock (MFAL) provide estimates for emissions and removals from the LULUCF sector. TurkStat is responsible for processing the CRF tables and for compiling the NIR.

In 2011, net removals from the LULUCF sector were estimated at -43.6 MtCO2eq/yr, to be compared with -15.4 MtCO2eq/yr in 1990: it is estimated that net removals increased by 184%.

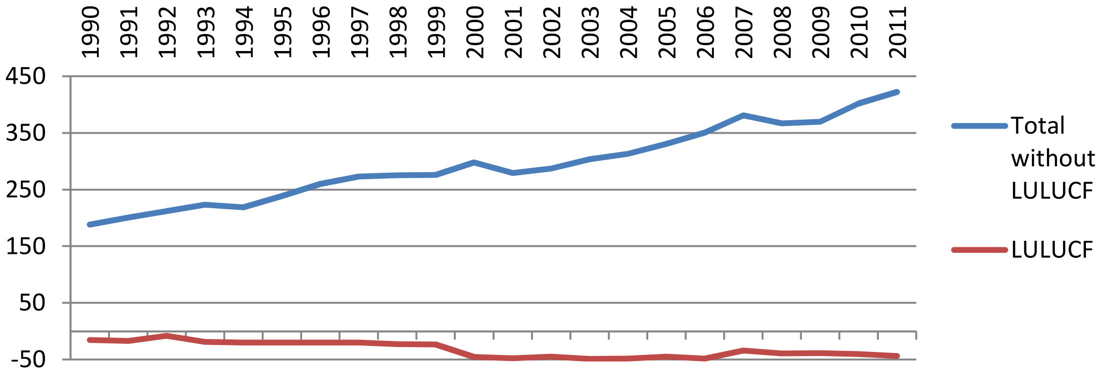

Figure 21 - Total GHG without LULUCF and GHG from LULUCF (MtCO2eq/yr) from 1990 to 2011 (UNFCCC, 2013)

At of 2011, the LULUCF sector was estimated to be a net sink and to offset the equivalent of 12% of the total GHG emissions from Turkey:

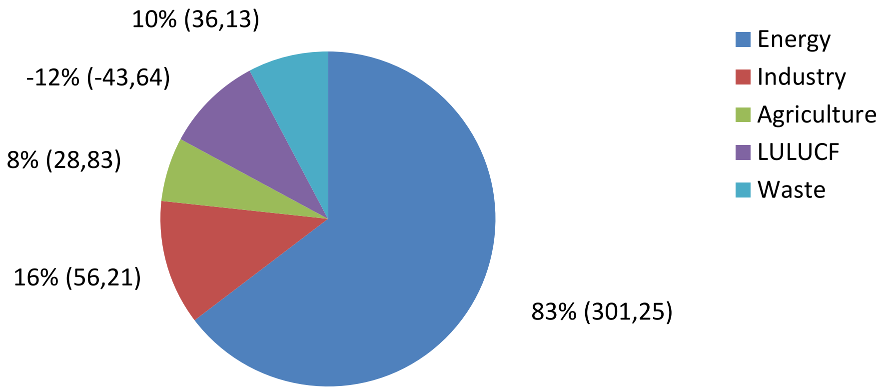

Figure 22 - Sectoral distribution of GHG emissions/removals (in MtCO2eq and %) in 2011 (UNFCCC, 2013)

The 2011 estimates for LULUCF sector were as follow: net removals (sink) of -61.8 MtCO2eq/yr from FL; net emissions (source) of 14.8 MtCO2eq/yr from CL; net emissions of 3.38 MtCO2eq/yr from GL; marginal net emissions of 0.02 MtCO2eq/yr from WL. Net emissions/removals from Settlements and Other land were not estimated:

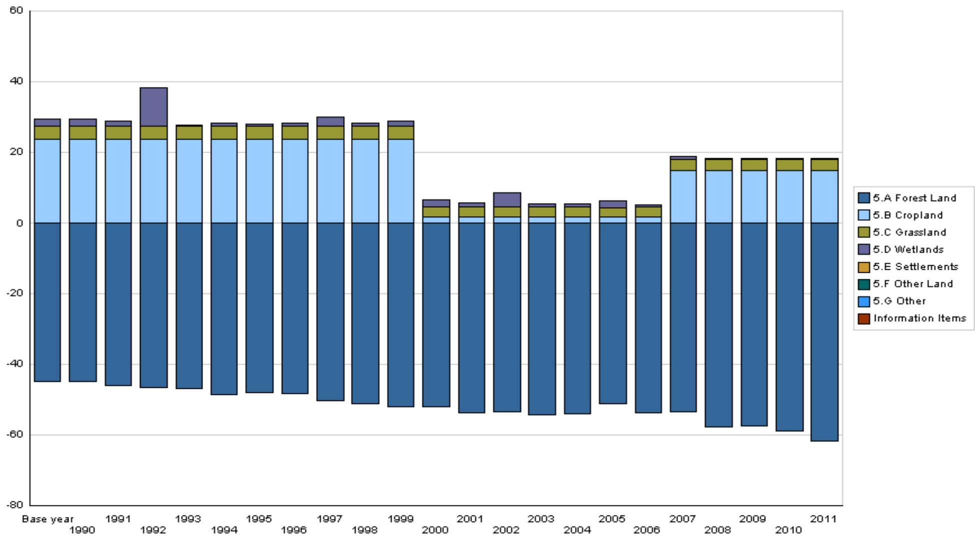

Figure 23 - GHG inventory for LULUCF in Turkey (MtCO2eq/yr) from 1990 to 2011 (UNFCCC, 2013)

It has to be noted that in the NIR 2009, the estimations were completely different for CL and GL, with net-removals respectively estimated at -18.5 MtCO2eq/yr and -6.6 MtCO2eq/yr. The reasons for these changes will be explained latter (see **Part 3.3 infra**).

➔ 5.A.1 - GHG emissions/removals from FL remaining FL (FL-FL)

These GHG emissions/removals are reported in the CRF tables 5.A.1 of the UNFCCC inventory. From 1990 to 2011, the FL-FL sink is estimated to have increased by 38%, from -44.9 MtCO2eq/yr in 1990 to -61.8 MtCO2eq/yr in 2011 (See detailed data in **Excel sheet 5A NIR**):

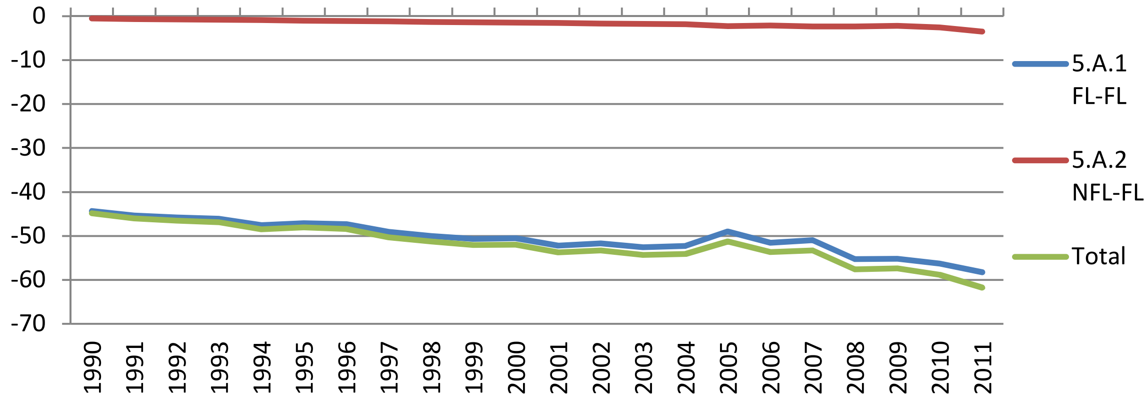

Figure 24 - GHG emissions/removals from FL-FL and NFL-FL (MtCO2eq/yr) from 1990 to 2011 (UNFCCC, 2013)

GHG emissions/removals from FL-FL are estimated using the Tier 1 approach of the GPG-LULUCF 2003. In terms of carbon pool, living biomass (above-ground and below-ground) and dead wood are reported; litter and soils are omitted. In terms of activity data, the NFI 1972 and NFI 2004 are used for 1990-2004 (interpolation) and ENVANIS is used for 2004-onward.

There is a concern here, as the area considered under FL-FL is constant over 1990-2004, then increases gradually from 2004 (20 570 000 ha) to 2010 (20 756 000 ha), before to decrease in 2011 (20 590 000 ha). Indeed, the FL-FL area reported in the CRF table 5.A.1 can decrease over time, in case of deforestation (FL-NFL), but it cannot increase over time, because afforestation/reforestation (NFL-FL) is reported in the CRF table 5.A.2.

In terms of emission factors, 16 sub-categories, under FL-FL, are considered, based on a segmentation into four climate maps (cold-wet, hot-wet, cold-dry, hot-dry), two management regimes (managed vs unmanaged. NB: unmanaged forest, 3.96% of the total forest area, are protected areas and considered at carbon equilibrium) and two forest types (coniferous vs deciduous).

It is estimated that net removals (in tCO2eq/ha/yr) have increased regularly from 1990 to 2011, passing from -2.16 tCO2eq/ha/yr in 1990 to -2.83 tCO2eq/ha/yr in 2011 (+31% over the period, -2.45 MtCO2eq/ha/yr in average):

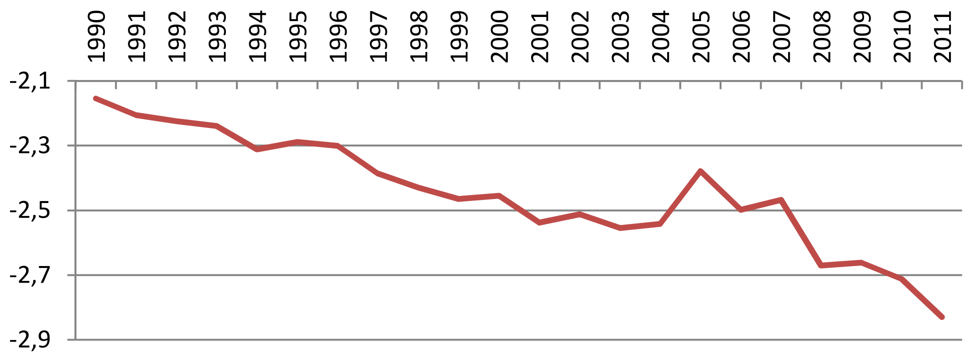

Figure 25 - Net removals (in tCO2eq/ha/yr) in FL-FL (BOUYER, 2014, based on UNFCCC, 2013)

Removals from FL-FL are said to be calculated "*according the Equations 3.2.3 and 3.2.5 of the GPG-LULUCF 2003*" (NIR, 2013). However, the first equation is the basis for the "*Stock-change approach*" while the second is the basis for the "*Gain-loss (or default) approach*"…and these two approaches are exclusive from one another, so it appears difficult to know which approach was used.

In addition, in the explanations provided, there is no mention of Equation 3.2.4 of the GPG-LULUCF 2003, which should have been used to calculate ΔCffg for the 16 sub-categories under FL-FL, in case the gain-loss approach was used:

$$\text{Equation 3.2.4} \qquad \Delta Cffg = \sum ij\ (Aij\ x\ Gtotalij) X\ CF$$

Where

ΔCffg = annual increase in carbon stocks due to biomass increment in FL-FL by forest type and climatic zone (tC/yr)

Aij = area of FL-FL, by forest type (i = 1 to n) and climatic zone (j = 1 to m) (ha)

Gtotalij = average annual increment rate in total biomass in units of dry matter (dm), by forest type (i = 1 to n) and climatic zone (j = 1 to m) (tdm/ha/yr)

CF = carbon fraction of dry matter (default = 0.5), (tC/tdm.)

Emissions from FL-FL are calculated using the gain-loss approach, with Equations 3.2.6 (general equation: total loss of biomass = commercial fellings + firewood + other losses), 3.2.7 (loss due to commercial fellings), 3.2.8 (firewood), 3.2.9 (other losses) of the GPG-LULUCF 2003. The supporting assumptions and calculations are not well detailed:

- Commercial fellings: The data series used in the NIR is not mentioned, so it appears difficult to assess the robustness of the calculations;
- Firewood: The data series used in the NIR is also not mentioned. It has to be noticed that 1990-2004 net emissions coming from firewood are assumed to be constant and equal to the net emissions from firewood in 2004 (i.e. 1 468 150 tCO2eq/yr), while the data series show a regular decrease from 1990 to 2004 in terms of firewood consumption;
- Other losses: The data series used in the NIR is also not mentioned.

Annual change in carbon stocks in dead wood in FL-FL are calculated, using Equation 3.2.10 (general equation: total change in dead organic matter = change in dead wood + change in litter), 3.2.11 and 3.2.12 (change in dead wood) of the GPG-LULUCF 2003. Equation 3.2.13 (change in litter) of the GPG-LULUCF 2003 is not used, as litter is omitted (lack of available data)

Non-CO2 emissions are estimated with Equation 3.2.19 (estimations of non CO2 emissions from C released) and Equation 3.2.20 (estimation of GHGs directly released in fire) of GPG-LULUCF 2003, using default data for “fuel on the land” (taken from Table 3.A.1.13) and “combustion efficiency” (45%, taken from Table 3.A.1.14 of the same document).

All the Equations of the GPG-LULUCF 2003 related to carbon stock changes and non-CO2 emissions from FL-FL soils are omitted: 3.2.14 (annual change in carbon stocks in FL-FL), 3.2.15 (CO2 emissions from drained organic forests soils), 3.2.16 (soil organic carbon contents), 3.1.17 (Direct N2O emissions from managed forests), and 3.2.18 (Direct N2O emissions from forest fertilisation).

GHG emissions from forest fires are estimated according to the Equations 3.2.19 (non-CO2 emissions from carbon released) and 3.2.20 (GHGs directly released in fires) of the GPG-LULUCF 2003.

The levels of uncertainty of parameters (e.g. oven dry weight, root-to-shoot ratio, etc.) and equations (e.g. annual carbon decrease in living biomass) are mentioned, as well as Equations 5.2.1 (estimate of overall uncertainty of data coming out of a multiplication) and 5.2.2 (estimate of overall uncertainty of data coming out of a sum) of the GPG-LULUCF 2003. However, it appears difficult to know whether these values come from expert view or from the use of Equations 5.2.1 and 5.2.2, as there is no detail.

➔ 5.A.2 - GHG emissions/removals from NFL becoming FL (NFL-FL)

These GHG emissions/removals are reported in the CRF tables 5.A.2 of the UNFCCC inventory. From 1990 to 2011, the NFL-FL sink is estimated to have been multiplied by more than six, from -0.55 MtCO2eq/yr in 1990 to -3.54 MtCO2eq/yr in 2011. Only CL-FL and GL-FL are reported under NFL-FL, since there is no adequate data for WL-FL, S-FL, and OL-FL.

In terms of activity data, it was estimated that NFL-FL increased by nearly six, from 186 000 ha in 1990 to 1 089 000 ha in 2011: CL-FL increase from 74 000 ha in 1990 to 435 000 ha in 2011, and GL-FL increase from 111 000 ha in 1990 to 653 000 ha in 2011. It can be noticed that these increases were particularly strong from 2009 to 2011.

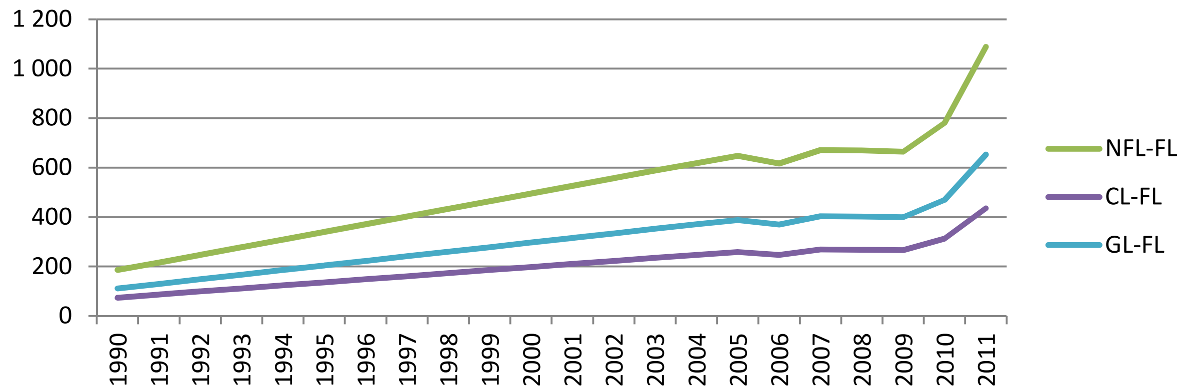

Figure 26 - Area changes (kha) from 1990 to 2011 in NFL-FL, esp. CL-FL and GL-FL (UNFCCC, 2013)

It was estimated that net removals (in tCO2eq/ha/yr) in CL-FL and GL-FL remained the same from 1990 to 2004, respectively at -2.88 tCO2eq/ha/yr and -3.03 tCO2eq/ha/yr, before to drop considerably in 2005, up to -3.49 MtCO2eq/ha/yr for both land use changes. After that, it was estimated that removals stayed the same for CL-FL and GL-FL and decreased irregularly from 2005 to 2011 (-3.25 MtCO2eq/ha/yr).

Over the period, average and increase of net removals are respectively estimated at -3.04 MtCO2eq/ha/yr and +13% for CL-FL, -3.15 MtCO2eq/ha/yr and +7% for GL-FL. Clearly, there are inconsistencies in these figures (see **Part 3.3 infra**):

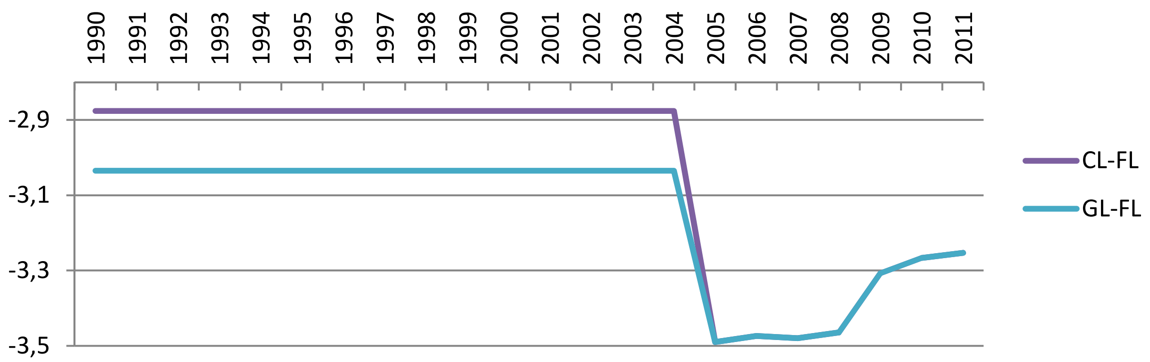

Figure 27 - Net removals (tCO2eq/ha/yr) in CL-FL & GL-FL from 1990 to 2011 (BOUYER, 2014, based on UNFCCC, 2013)

As for FL-FL, there is a methodological concern: there is a mix of Stock change approach and Gain-loss (default) approach, while the GPG-LULUCF 2003 does not provide for a Stock-change approach for the estimation of net emissions in NFL-FL. Related directly with the foregoing

- Equation 3.2.3 (annual change in carbon stocks in living biomass in FL-FL - Stock change approach) of the GPG-LULUCF 2003 is used here, while it theoretically applies to Stock change approach and FL-FL;
- Equations 3.2.5 (average annual increment in biomass), 3.2.9 (annual other losses of carbon) and 3.2.10 (annual change in carbon stocks in dead organic matter) are used, while they all theoretically apply to FL-FL;
- Equation 3.2.23 of the GPG-LULUCF 2003 (annual increase of carbon stocks in living biomass in NFL-FL, using the Gain-loss approach) is missing.

Only carbon emissions in NFL-FL are correctly estimated with the Gain-loss approach and Equations 3.2.24 (annual decrease of carbon stocks in living biomass in NFL-FL), and 3.2.27 (or 3.2.28 alternatively: annual change in carbon stocks in dead wood in NFL-FL) of the GPG-LULUCF 2003.

As for FL-FL, adequate data on soil and litter are missing: therefore, Equations 3.2.29 (or 3.2.30 alternatively: annual change in carbon stocks in litter in NFL-FL), 3.2.21 (annual change in carbon stocks in mineral soils in NFL-FL), 3.2.22 (annual change in carbon stocks in mineral soils upon afforestation), and 3.2.23 (CO2 emissions from drained organic soils in NFL-FL) of the GPG-LULUCF 2003 are omitted.

➔ 5.A - GHG emissions/removals in FL-FL and NFL-FL: UNFCCC estimate vs FAO estimate

In the FAO FRA 2010, forest carbon stocks are estimated for four sub-categories of forests: coniferous vs deciduous and FL (i.e. more than 10% of tree crown cover) vs OWL (i.e. between 1% and 10% of tree crown cover), with the following Equations from the FAO FRA 2010 Guidelines (See detailed data in **Excel sheet C FAO**):

- AGB = GS × BCEF where: AGB = Above-Ground Biomass (t), GS = Growing Stock (m3 over bark), and BCEF = Biomass Conversion and Expansion Factor (t/m3);
- BGB = AGB × R, where BGB = Below-Ground Biomass (t), and R = Root-to-shoot ratio.

Forest types	GS	BCEF	R	AGB	BGB	CF AGB	CF BGB	AGB	BGB	Deadwood	Litter	Soil	All C pools
Unit	m3/ha	tdm/m3	ø	tdm/ha	tdm/ha	Ø	Ø	tCO2/ha	tCO2/ha	tCO2/ha	tCO2/ha	tCO2/ha	tCO2/ha
Coniferous / FL	116	0,75	0,29	87,0	25,2	0,51	0,26	162,7	24,1	1,6	80,7	34,0	303,0
Coniferous / OWL	8,98	3	0,4	26,9	10,8	0,51	0,26	50,4	10,3	0,5	22,0	34,0	117,2
Broadleaves / FL	176	1,05	0,24	184,8	44,4	0,48	0,23	325,2	37,4	3,3	47,7	34,0	447,6
Broadleaves / OWL	7,98	3	0,46	23,9	11,0	0,48	0,23	42,1	9,3	0,4	7,3	34,0	93,2
GS: OGM, 2006													
BCEF: Default values extracted from Table 5.4 of the FAO FRA 2010 Guidelines													
R: Default values extracted from Table 5.6 of the FAO FRA 2010 Guidelines													
CF (ratio tC/tdm): Default values extracted from Table 5.6 of the FAO FRA 2010 Guidelines													
tCO2 = 44/12 tC													
Deadwood: Assumption made in the Turkish report for FAO FAO FRA 2010 that C in deadwood = 1% of C in AGB													
Litter: Default values in warm temperate moisture climate extracted from Table 5.9 of the FAO FRA 2010 Guidelines													
Soil: Default value in warm temperate moisture climate / sandy soils extracted from Table 5.10 of the FAO FRA 2010 Guidelines													

Table 7 - Forest carbon stocks (tCO2/ha) in coniferous vs deciduous and FL vs OWL (FAO FRA, 2010)

Based on these assumptions and taking into account the share of areas between FL vs OWL, the AGB and BGB carbon stocks (in tCO2) are estimated below:

	1990	2000	2005	2010
FL - AGB (tdm)	1 086 993 000	1 175 377 000	1 238 521 000	1 301 665 000
FL - BGB (tdm)	292 104 000	316 406 000	333 180 000	349 955 000
OWL - AGB (tdm)	na	na	267 450	272 667
OWL - BGB (tdm)	na	na	112 436	114 629
FL+OWL - AGB+BGB (tC)*	689 548 500	745 891 500	786 040 443	826 003 648
FL+OWL - AGB+BGB (tC02)**	2 528 344 500	2 734 935 500	2 882 148 291	3 028 680 043
% of C stock from FL	*na*	*na*	*99,98%*	*99,98%*
% of C stock from OWL	*na*	*na*	*0,02%*	*0,02%*
		1990-2000	**2000-2005**	**2005-2010**
Annual change (tCO2/yr)		-20 659 100	-29 442 558	-29 306 350

Table 8 - Estimates of carbon stock changes in FL-FL for 1990-2010 (BOUYER, 2014, based on FAO FRA, 2010)

If we compare the UNFCCC and FAO FRA estimates for the annual change of forest carbon stocks, using the same carbon pools (AGD and BGB only) and the same activity data (FL and OWL), they look very different, with UNFCCC values being 80% to 135% "higher" (in terms of sinks) than FAO FRA values.

Annual change (tCO2/yr)	1990-2000	2000-2005	2005-2010
FAO FRA 2010	-20 659 100	-29 442 558	-29 306 350
UNFCCC 2013	-48 623 619	-53 123 870	-55 340 861
Diff (UNFCCC vs FAO FRA)	135%	80%	89%

Table 9 - Differences of forest carbon stocks estimates in NIR 2013 vs FAO FRA 2010 (BOUYER, 2014)

NB: The fact that carbon stocks in OWL are not accounted for in 1990 and 2000 for the FAO FRA estimate (at the contrary in the UNFCCC estimate) does not really matter, because the % of carbon stocks from OWL (compared to the total in FL and OWL) is marginal (0.02%).

➔ 5.B - GHG emissions/removals from CL-CL and NCL-CL

These GHG emissions/removals are reported in the CRF tables 5.B of the UNFCCC inventory. From 1990 to 2011, the CL-CL source is estimated to have decreased by 30%, from 25.8 MtCO2eq/yr in 1990 to 18.1 MtCO2eq/yr in 2011, and the NCL-CL sink is estimated to have increased by 70%, from -3.4 MtCO2eq/yr in 1990 to -2.0 MtCO2eq/yr in 2011:

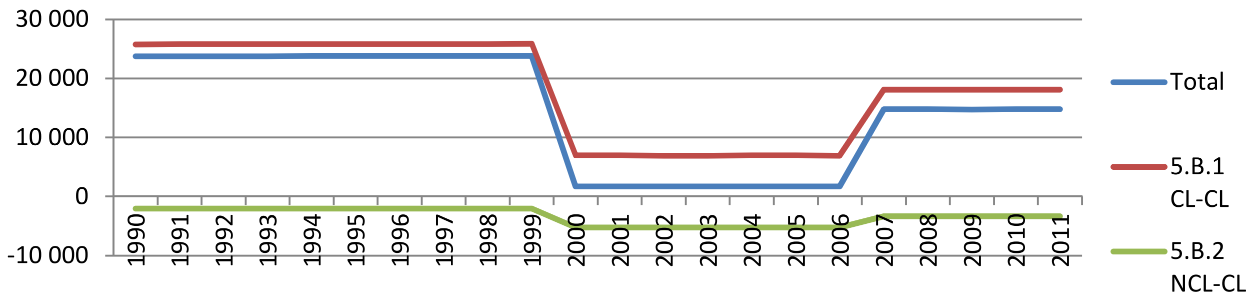

Figure 28 - GHG emissions/removals (ktCO2eq/yr) in CL-CL and NCL-CL from 1990 to 2011 (UNFCC, 2013)

These apparent good results do not really match with qualitative judgements made in other sources: "*traditional agriculture techniques such as excessive fertilizer use, stubble incineration and heavy tillage are being widely used among the 26.5 Mha of CL[…] with 13.5 Mha (in 2004) of meadows and pastures which have an important position as CO2 sink, Turkey as a rich potential. But the concept of management of these fields is poor at administrative level as well as among villagers*" (NC1, 2007);

GHG emissions/removals from CL-CL and NCL-CL are estimated using the Tier 1 approach of the GPG-LULUCF 2003. In terms of activity data, the CORINE Land Cover (CLC) maps 2000 and 2006 (and 1990 for the first time in the 2011 GHG inventory) are used. Between 1990 and 2006, activity data are interpolated, after 2006, they are extrapolated (NB: a CLC map 2012 is under preparation).

There are two major concerns about the activity data used for CL, and other land uses apart from FL:

- Land use data are not consistent between FL (based on NFI 1972 and 2004, and ENVANIS 2005-2013) and all other land uses (CLC maps 1990, 2000, and 2006). Some land use classes may overlap between FL and other land uses, like meadows for instance: "*10 Mha of land identified as sparsely vegetated areas are either included in the forest property or not. These areas can be accounted as natural meadows since they are empty*" (NCCAP, 2011);
- "*CLC maps constitute an important baseline but are not sufficient to fulfil the requirements of LULUCF reporting. They have not been adapted to meet the needs of the LULUCF NIR. While they comprise in principle the required information […] CLC data need to be refined*" (UNDP, 2011).

  Not only the correspondence between the land uses classes in CLC maps and the NIR are not straight forward, but the precision of CLC maps (25 ha) would not match with the required precision of the KP (at least 1 ha for minimal mapping unit), in the absence of a sample-size class distributions to estimate land use areas from low precision land use monitoring (as explained in 4.2.2.5.2 of the GPG-LULUCF 2003).

As a result, there are very big differences between CL and GL areas estimated in the GHG inventories 1990-2011, the NIR 2013, and TARIM (TurkStat, 2013). For instance: "*The total area of CL in Turkey was 28 774 210 ha in 2006. In 1990 it was 31 259 930 ha*" (NIR, 2013). In TARIM, the estimated areas are 25 876 000 ha in 2006 and 27 856 000 ha in 1990! In the CRF tables of the GHG inventories, the estimated areas are 852 000 ha in 2006 and 952 000 ha in 1990!

The fifth NC gives further details about the land use changes in the agriculture sector: "*In 2009, Turkey had 24.3 Mha under agricultural land management, 16.2 Mha planted, 4.3 Mha of fallow, 0.8 Mha of vegetable gardens and 3 Mha of fruit gardens, olive groves and vineyards. Since 1988 however, there has been a significant decline in agricultural land in Turkey*" (NC5, 2013):

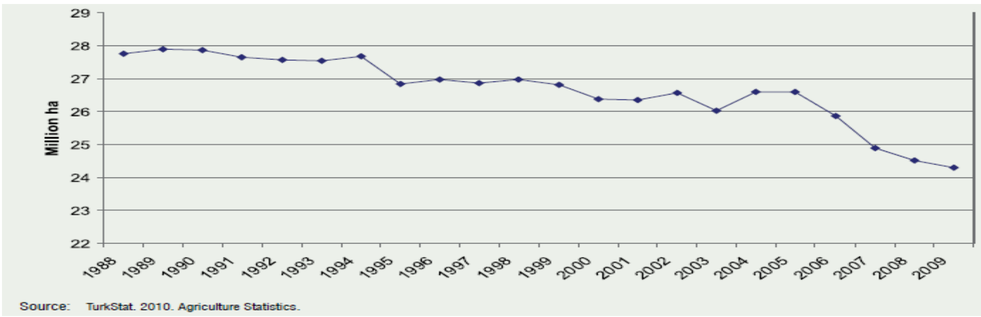

Figure 29 - Area change from 1990 to 2019 in the agriculture sector (TurkStat, 2010)

In addition to the inconsistencies in terms of total area, is seems there is an inversion between areas of annual CL (ACL) and areas of perennial CL (PCL) in the NIR, 2013: areas under ACL seem eight times less than areas under PCL, while TARIM shows the opposite ratio.

It seems the inconsistencies in terms of AD in the last NIR 2013 were aggravated with the recent change of AD series, from three different map types (Land Use Survey 1980, CLC2000, CLC 2006, Statip 2010) to just CLC (1990, 2000, 2006). All the land uses and land use changes categories have been recalculated: there may be the need for a complete review of these recalculations.

In terms of emission factors, sub-categories under CL-CL and NCL-CL are considered, based on segmentation into four climate maps (cold-wet, hot-wet, cold-dry, hot-dry), soil types, and ACL vs PCL. Explanations about these classifications are not provided in the NIR 2013, but appear in the NIR 2006: "*TurkStat and MARA have collaborated on collection of annual farmer records for each cultivated crops. These records were collected by town branches of MARA and were sent to TurkStat yearly […] Soil data are gathered from MARA […] a query was made on soil database based on sub-province boundaries using GIS techniques […] In order to select default parameters mentioned in LULUCF guidance, top soil texture and climate zones are required. To do so, four climate zones* [were created] *using local statistical methods by help of GIS (ArcGIS)*" (NIR, 2006).

The carbon stocks change in biomass has been estimated only for PCL. For ACL, the increase in carbon stocks in the biomass is assumed equal to decrease of carbon stocks in the biomass.

The estimates for net removals (in tCO2eq/ha/yr) for CL-CL and NCL-CL are highly variable between 1990 and 2011, with a value ranging from 10.4 tCO2eq/ha/yr to 40.8 tCO2eq/ha/yr (mean: 28.3 tCO2eq/ha/yr) for CL-CL and a value ranging from -28.2 tCO2eq/ha/yr to -8.3 tCO2eq/ha/yr (mean: -16.2 tCO2eq/ha/yr) for NCL-CL (GL-CL in practice, since FL-CL is not estimated).

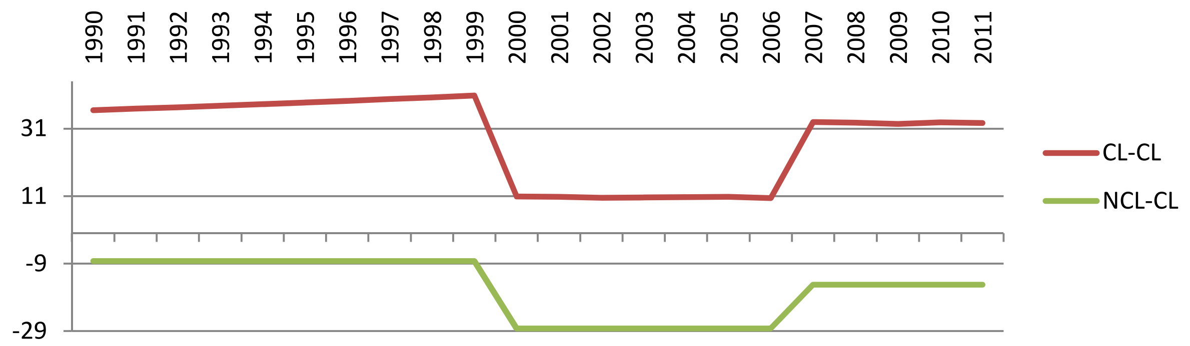

Figure 30 - Net removals (tCO2eq/ha/yr) in CL-CL and NCL-CL from 1990 to 2011 (UNFCCC, 2013)

Clearly, these figures and trends are not reliable and the limited explanations provided in the NIR 2013 do not allow understanding them: "*5B used to be a sink in previous submission but it has become a source with the addition of conversions within the category of CL-CL and NCL-CL*" (NIR, 2013)

In terms of calculations, five set of explanations are presented as follow in the NIR 2013:

- Estimation of biomass growth of PCL, including poplar plantations:
  - Use of Tier 1 and Tier 2, without further details on where these Tier were applied;
  - Use of Gain-loss method, with reference made to Equations 2.7 and 3.1.1 of GPG-LULUCF 2003 (no Equation 2.7 in the GPG-LULUCF 2003?);
  - Use of default value of 2.1 tC/ha/yr for biomass growth for PCL, extracted from Table 3.3.2 of GPG-LULCUF 2003. Considering that chestnut represent 28.7% of the area of PCL in 2012, olive 22.4%, and pistachio 8.5% (Tuik, 2012), the average age of these main crops was calculated (38.7 years) and multiplied by 2.1 tC/ha/yr, giving a value of 81.2 tC/ha for PCL;
  - Use of a "poplar database" covering 2003-2010, and extrapolated before 2003 and after 2011. Country-specific data are presented (basic wood density, volume increment, rotation period, biomass expansion factor, root-to-shoot ratio), but the activity data series are not presented. According to the FAO, there were 125 000 ha of poplars in 2008 (FAO, 2011);
  - For PCL, litter and deadwood are not considered, and BGB is considered only for poplars (without further detail for this last point);

- Estimation of biomass gain/loss for ACL-PCL. The explanations are also scarce: use of Tier 2, no mention of Equations used. At least, a conversion matrix (ACL-PCL and vice-versa) is presented for years 1990, 2000 and 2006, disaggregated into 16 land uses (four soil types and four climate types – warm/dry, warm/wet, cold/dry, cold/wet). The same carbon stocks were considered (81.2 tC/ha for PCL and 5 tC/ha for ACL);
- Estimation of carbon stock changes in mineral soils for ACL-PCL and vice-versa. The explanations are a bit more developed: use of Tier 2, use of the Equation 3.3.3 of GPG-LULUCF 2003, with default data were taken from Table 3.3.4 for mineral soils and Table 3.3.5 for organic soils;
- Estimation of GHG emissions from organic soils in CL. The explanations are very limited: use of Tier 2, no mention of Equations used;
- Estimation of biomass gain/loss for GL-ACL and GL-PCL. The Equation 3.1.1 (Gain-loss approach) of GPG-LULUCF 2003 is used, considering the following carbon stocks: 5 tC/ha for ACL, 81.2 for PCL, 3.7 tC/ha for GL.

In terms of uncertainty, there is only one uncertainty level estimated, for biomass loss and gain in CL. The uncertainty estimate is assumed to be +/-90%, based on the uncertainty level on the emission factors (assumed to be +/-75%, according to Table 3.3.2 of the GPG-LULUCF 2003) and the uncertainty level on the activity data (assumed to be +/-50% according to expert view).

It seems Equation 5.2.1 (estimate of overall uncertainty of data coming out of a multiplication) of the GPG-LULUCF 2003 would be more adequate than Equation 5.2.2 (estimate of overall uncertainty of data coming out of a sum) to calculate this uncertainty level, the emission factors being multiplied by activity data.

➔ 5.C: GHG emissions/removals from GL-GL and NGL-GL

These GHG emissions/removals are reported in the CRF tables 5.C of the UNFCCC inventory. From 1990 to 2011, GL-GL is estimated to be a marginal source (slightly decreasing from 0.02 MtCO2eq/yr in 1990 to 0.01 MtCO2eq/yr in 2011), and NGL-GL is assumed equal to CL-GL (reporting for FL-GL assuming to be "Not Applicable") and equal to 3.37 MtCO2eq/yr in average over the period, with three stable values (from 1990 to 1999, 2000 to 2006, 2007 to 2011):

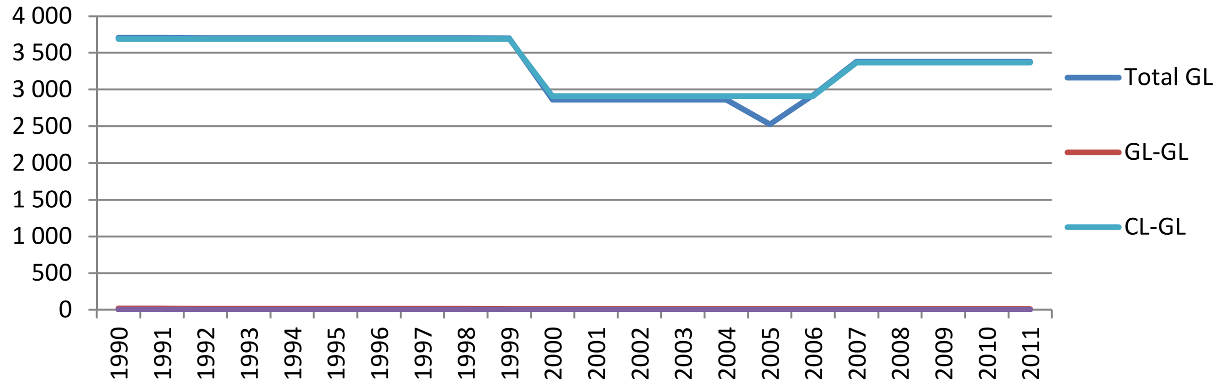

Figure 31 - GHG emissions/removals (ktCO2eq/yr) from GL-GL and NGL-GL from 1990 to 2011 (UNFCCC, 2013)

Explanations in the NIR 2013 are very scarce "*Carbon stock change in GL-GL is assumed to be not changing if management is not changed. GL rehabilitation projects implemented in the country but conservatively we assumed no change in biomass. We plan to report these projects as the GL monitoring system becomes available in the next submission. Emissions from organic soils are reported, using default emission factor and disaggregated activity data […] For CL-GL, the same calculations than for GL-CL are carried out*" (NIR, 2013).

As for FL and CL, there is a concern about the reported areas: activity data for GL-GL and FL-GL are "Not Estimated" (while GHG emissions/removals are reported for GL-GL, which is inconsistent) and activity data for NGL-GL are assumed to be made only of CL-GL, with small areas of land uses every year (139 000 ha to 343 000 ha) while the total area of GL is assumed to be ranging from 12.4 to 14.6 Mha during the same period (TurkStat, 2012).

The net removals for CL-GL are highly variable between 1990 and 2011, with a value ranging from 8.5 to 26.6 tCO2eq/ha/yr (mean: 18.3 tCO2eq/ha/yr). The limited explanations provided in the NIR 2013 do not allow understanding these figures and trends.

➔ 5.D: GHG emissions/removals from WL-WL and NWL-WL

The first NC underlines the importance of WL in Turkey "*It was exceptionally rich WLs compared to the Middle East and the European countries […] The WLs cover an area of 78 356.2 ha*" (NC1, 2007). The NCCAP further recalls this importance "*marshes, that cover some 3‰ of the total surface area in Turkey, are important in terms of GHG emissions*" (NCCAP 2011).

The reporting for 5.D started in 2009, but it is limited to CL-WL and GL-WL. FL-WL and WL-WL are not estimated. The only explanation given in the NIR 2013 is about the use of Equation 3.1.1 (Gain-loss approach) of GPG-LULUCF 2003. There is no detail about the emission factors used for WL.

These GHG emissions/removals are reported in the CRF tables 5.D of the UNFCCC inventory. From 1990 to 2011, GL-WL is estimated to be a marginal source, ranging from 0.12 to 0 MtCO2eq/yr and CL-WL is extremely variable, ranging from 10.9 (in 1992) to 0.02 (in 2011) MtCO2eq/yr, with a mean of 1.57 MtCO2eq/yr over the period:

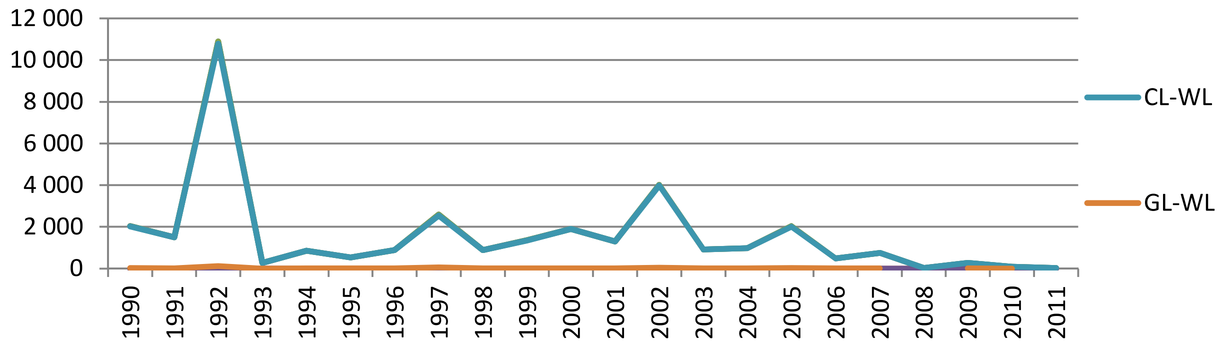

Figure 32 - GHG emissions/removals (ktCO2eq/yr) in CL-WL and GL-WL from 1990 to 2011 (UNFCCC, 2013)

These high variations in GHG emissions/removals from CL-WL and GL-WL are directly linked to the high variations estimated for the related activity data (which are well below the real areas of GL):

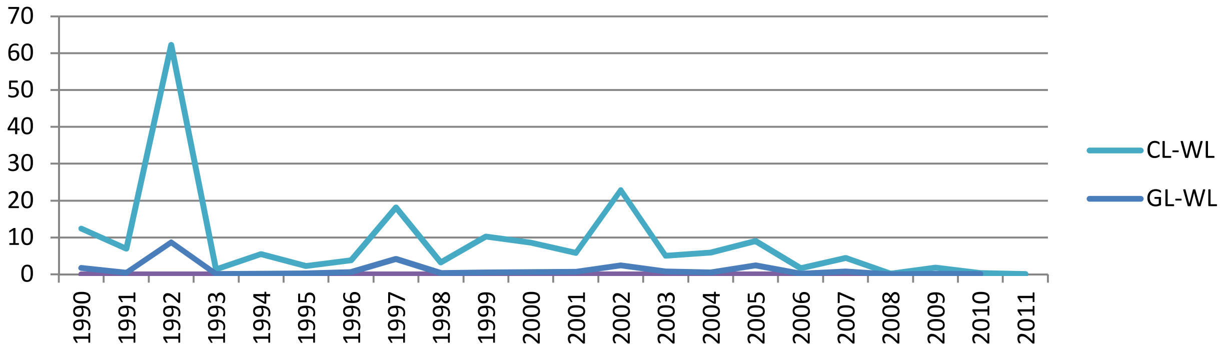

Figure 33 - Changes of areas (kha) in CL-WL and GL-WL from 1990 to 2011 (UNFCCC, 2013)

The net removals for CL-WL are high and variable between 1990 and 2011, with a value ranging from 131.6 to 446.6 tCO2eq/ha/yr (mean: 208.4 tCO2eq/ha/yr). As for GL-WL, net removals are much lower and stable, ranging from 13.4 to 13.8 MtCO2eq/yr (mean: 13.5 MtCO2eq/yr). The limited explanations provided in the NIR 2013 do not allow understanding these figures and trends.

The recent launching of the project "Adaptation to Climate Change and Protection of Biodiversity through Conserving and Sustainably Using Wetlands in Turkey" funded by the German Government) and implemented by the Wetlands Division of MFWW may provide information on carbon stocks in WL and the related land use changes, thus providing important baseline information.

3.3. Strengths and weaknesses of LULUCF GHG inventories

➔ **General comments from the Expert Review Team (ERT) on the 2011 inventory (ERT, 2012)**

Here below are summarised the main comments to the last GHG inventory:

Completeness: "*The inventory covers most source and sink categories but a number of categories are still reported as "NE". […] Thus, apart from carbon stock changes, the only other category reported for the LULUCF sector is a small amount of CH4 and N2O emissions from wildfires on FL (0.01 MtCO2eq/yr). It has to be noticed that there were improvements in the 2011 GHG inventory compared to the 2009 GHG inventory, where CRF tables (e.g. tables 5.D, 5.E, 5.F, 5(III)) and cells (e.g. parts of tables 5(II), 5(IV) and 5(V)) were left blank (no notation key), the time series for CL and GL were incomplete, and there were no estimates reported for WL*". It is worth noting that land uses change associated with deforestation (FL-CL and FG-GL especially) are not estimated, which is a major weakness, especially if a simulation of Art. 3.3 of the KP is to be carried out (See **Part 3.4 infra**).

Key categories: "*Turkey has included the LULUCF sector as a whole in its key category analysis, which is not in accordance with the GPG 2000 and the GPG-LULUCF 2003. The ERT recommends that Turkey […] report a 1990 key category analysis and trend analysis for the most recent inventory year both in the CRF table 7 and in the NIR in its next inventory submission. The ERT further recommends that Turkey use the key category analysis for its methodological choices and for prioritizing inventory improvements*". In the case of Turkey, this key-category analysis could be carried out using a "Tier 1 level and trend assessment, and qualitative considerations" (see **Part 2.4 supra**).

Tier: "*Turkey continues to mainly use lower-tier methods for calculating emissions from the key categories of its inventory. The ERT reiterates the recommendation from previous review reports that Turkey ensure that appropriate methods are used to estimate emissions from the key categories, in accordance with the IPCC good practice guidance*".

Uncertainties: "*The NIR indicates that the uncertainty analysis is mainly based on expert judgement. However, there are no further references and documentation on the values used in the analysis. The ERT reiterates […] that Turkey: document the rationale for uncertainties for all sectors when an expert judgement is used; take into account the results of the uncertainty analysis in its inventory improvement plan; and update uncertainty estimates for categories that are recalculated*". In the recently published fifth NC, the LULUCF sector is the first one in terms of combined uncertainty: 41.2%, with 40% of uncertainty on activity data and 10% of uncertainty on emission factors (NC5, 2013).

QA/QC: "*The NIR includes only limited information on general quality control (QC) procedures implemented and no documentation on quality assurance/quality control (QA/QC) performed. […]* [Turkey has to] *Clearly define all responsibilities of institutions/experts with regard to their contribution to the national GHG inventory, including QA/QC, and document this in its next NIR*";

Time series inconsistency for activity data: It exists across different reporting categories (5A vs 5B to 5D. See **Part 3.2 supra**), but also within the reporting categories. For instance, inconsistencies between the 1990-2004 period (interpolation from the two NFIs performed in 1972 and 2004) and the 2005-2011 period (interpolation from the ENVANIS database) are noted in the NIR 2013, but there is no detail on how the data series were adjusted. More generally, it is difficult to understand the data flows between NFIs, ENVANIS, and CLC database, but also the Digitized Basin Improvement Studies (OGM), the GIS-based Positional Forestry Information System (KORBİS – OGM), the Digitized Stand Maps and Other Statistical Data (OGM), the Fire Management Information System (OGM).

Transparency: "*The information in the NIR is still incomplete and is partially unclear in all sectors. The reporting is mainly at the aggregated level and does not include specific information on the rationale of the choice of methods, description of the methods, assumptions and activity data. Furthermore, it does not include references to the external sources used for inventory preparation, information on uncertainties, QA/QC procedures, and planned improvements*".

Inventory management: "*Turkey has no centralised archiving system […] The ERT encourages Turkey to develop a centralized archiving system containing: disaggregated emission factors and activity data, and documentation on how these factors and data have been generated and aggregated; all underlying calculation sheets, as well as all cited literature; internal documentation on QA/QC procedures, external and internal reviews; and documentation on annual key categories and key category identification and planned inventory improvements. […] An emissions inventory portal is still* *in the process of being developed. […] The ERT […] recommends that Turkey continue its efforts to establish the portal*".

➔ Specific comments from the ERT on the LULUCF section of the 2011 inventory (ERT, 2012)

Comments for all LULUCF Categories:

Most of the general comments presented also apply to the LULUCF Categories: (i) Lack of key-category analysis, (ii) Lack of key activity data for consistent representation of land areas, especially for key categories, such as FL-NFL, CL and GL, (iii) Lack of documentation for expert judgement, (iv) Lack of transparency, especially the absence of "*section in the NIR describing the methods used to derive biomass and soil carbon stock changes in CL and GL, although there are estimates for some years*".

In addition, the ERT recommend "*The establishment of a permanent team to work on LULUCF studies and the improvement of the capacity of the staff and institutions concerned*"

Comments for the key category - FL-FL (CO2)

- No standard NFI system, no definition of FL or how the land is divided between FL-FL / NFL-FL;
- No disaggregation of the FL-FL category into climatic zones or forest management types;
- Use of a "Stock change approach" (tier 2 method) with country-specific emission factors to estimate biomass gains, but use of the "Gain–loss (default) approach" (tier 1 method) to estimate biomass losses;
- Need for complete and transparent documentation explaining how the parameter for annual transfer into dead wood (Binto) of the Equation 3.2.11 of the GPG-LULUCF 2003 is calculated and applied, because there is a possible overestimation of carbon accumulation in dead wood (e.g. doubling between 2007 and 2008);
- Encouragement to use a tier 2 approach for the estimation of emissions/reductions in the litter pools (using Equation 3.2.13 and default litter data in Table 3.2.1 of the GPG-LULUCF 2003).

Comments for the key category - CL-CL (CO2)

- No information at all relating to the CL areas in either the NIR or the CRF tables; nor is there any information on the method applied;
- According to FAOSTAT, Turkey had 26.5 Mha of CL in 2004, with 9% as PCL. Given the lack of activity data and considering the apparent large transitions in this category, the ERT would assume that the CL-CL areas may be 2.4 Mha (9% of 26.5 Mha) resulting in an implied emission factor (IEF) of 2.1 MgC/ha. The biomass removal rate from CL-CL would be the highest IEF for all reporting Parties (ranging from -0.59 MgC/ha to 2.10 MgC/ha), together with Malta (2.10 MgC/ha). Excluding Malta and Turkey, other Parties report IEFs in the range of –0.59 to +0.35 MgC/ha. These IEFs are the same as the crop biomass accumulation rate for temperate regions (see tier 1 approach for CL-CL in Table 3.3.2 of the GPG-LULUCF 2003). Considering that biomass losses from CL-CL would be similar to gains, as suggested by the GPG-LULUCF 2003, the ERT considers the estimated IEF for CL removals to be unreasonable.

Comment for the key category - GL-GL (CO2)

- No information at all relating to the CL areas in either the NIR or the CRF tables; nor is there any information on the method applied;
- The NIR provided information on areas under GL (81,613.8 ha) in 2007. The ERT notes that if the previous reported areas are used to derive an IEF for biomass removal (3 MgC/ha) these estimates seem unreasonable when compared with other reporting Parties (range: -0.005 to +0.5 MgC/ha).

Comment for the non-key category - NFL-FL (CO2)

- Unexplained fluctuations in NFL-FL from 2005 to 2009: annual afforestation for the period 2005 to 2009 varies from –2.12 to 50.5 kha/yr. This is further confounded by a 30.9 kha increase in FL-FL for the period 2005 to 2009.

Comment for the non-key category - FL-NFL (CO2)

- FL-CL, FL-GL, and FL-OL are estimated as NA. FL-WL and FL-Settlements are estimated as NE. Therefore, there is no estimate of net emissions due to deforestation.

➔ Foreseen improvements in LULUCF GHG inventories

These improvements are cited on the last NIR (NIR, 2013) and a presentation made on the LULUCF GHG reporting (ERDOGAN, 2013):

- Creation of a "Climate Change and Sink Areas Expertise Committee" under the OGM, in February 2013, in order to improve the estimation of forestry related GHG in the UNFCCC inventory;
- Preparation of CLC map for 2012, available in the NIR 2014 and increasing the reliability of land use data;
- Establishment of a remote sensed and web based "LULUCF monitoring system";
- Finalisation of a country-specific QA/QC plan within the LULUCF sector;
- Finalisation of a computer based GHG estimating system with TurkStat, by the end of 2013.
- Reporting under 5.E in the NIR 2014, by determining C stocks in settlements (project "TUBITAK - 112Y096"), since urban sprawl is a common problem in many places of the country;
- Establishment in 2013 of (i) an Agriculture Database System (TARBIL), (ii) an Agricultural Parcel Information System (TARSIM), (iii) a Rural settlement database, and (iv) a national soil database for soil organic carbon;
- On-going support of the GEF-funded project "Integrated approach to management of forests in Turkey" to develop a MRV system for the Turkish forests. Five outputs are directly linked to this outcome: (i) develop country-specific methodologies, values, and QA/QC system, based on world's advanced measurement method, (ii) develop a LULUCF database compiling all relevant information, (iii) support the creation of a LULUCF unit at OGM, (iv) Train Government and field foresters on LULUCF monitoring, (v) Set up a pipeline of LULUCF mitigation projects.

3.4. Current and future policies impacting LULUCF by 2020

➔ National Climate Change Action Plan (NCCAP)

The Coordination Board on Climate Change (CBCC) was established in 2001 and restructured a first time in 2004 (after Turkey became a Party to the UNFCCC), a second time in 2010, and a third time in 2012. It has 14 members and 11 working groups, including one on LULUCF chaired by the OGM.

The CBCC and its working groups prepared a National Climate Change Strategy 2010-202, which was adopted in May 2010 by the Higher Planning Council. Then, based on this Strategy, a NCCAP was prepared and adopted in July 2011, as outlined below:

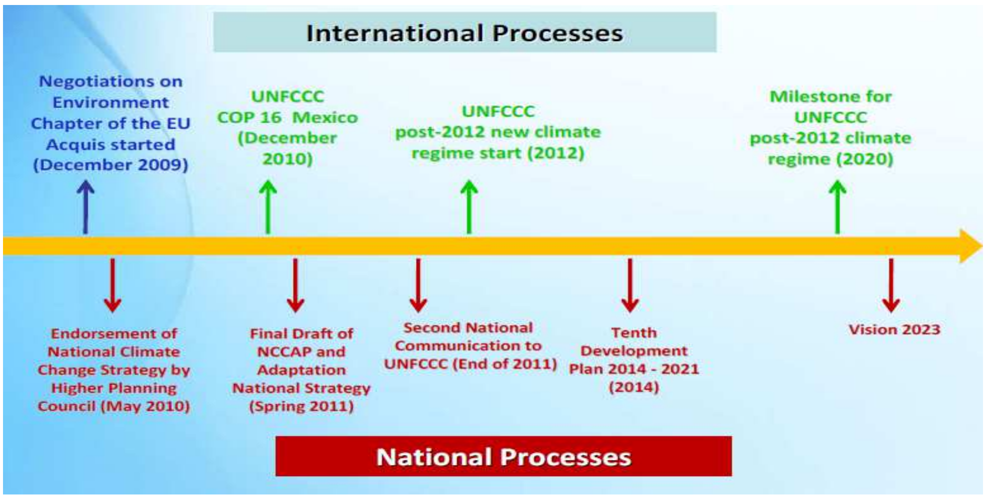

Figure 34 - NCCAP: links with the national and international processes on climate (MEF, 2011)

The NCCAP has a lot of objectives and actions directly or indirectly linked to LULUCF and included under the headings “Energy” (E), “Agriculture “ (T), “Forestry” (O):

Objectives		Actions
E2.1	Increase the share of renewable energy in electricity production: study the use of biomass resources in coal plants	E2.1.1.9
T1.1	Identify and increase the soil carbon stocks	T1.1.1.1 to T1.1.1.6 T1.1.3.1 to T1.1.3.3
T1.2	Identify and increase topsoil and subsoil biomass	T1.2.1.1
O1.1	Increase the amount of forest carbon stocks by 15% in 2020 compared to 2007: 14,500 Gg in 2007, 16,700 Gg in 2020	O1.1.1.1 to O1.1.1.10
O2.1	Reduce deforestation by 20% in 2020 compared to 2007	O2.1.1.1 to O2.1.1.5
O3.1	Integrate the climate change factor in LULUCF management strategies by 2015	O3.1.1.2 to O3.1.1.5
O3.2	Identify and increase the soil carbon stocks in CL as a result of agricultural forestry activities by 10% in 2020 compared to 2007	O3.2.1.1 to O3.1.2
O3.3	Identify and increase the soil carbon stocks in pastures and meadows by 3% in 2020 compared to 2012	O3.3.1.1 and O.3.3.1.2
O3.4	Identify and maintain the soil carbon stocks in WL in 2020 compared to 2012	O3.4.1.1 to O3.4.1.4 O3.4.2.1 to O3.4.2.4 O3.4.3.1 to O3.4.3.3
O3.5	Identify and maintain the soil carbon stocks in Settlements (through green planting) by 3% in 2020 compared to 2012	O3.5.1.1 to O3.5.1.3
O4.1	Make the necessary legal arrangements for combating climate change with regard to LULUCF by the end of 2013	O4.1.1.1 to O4.1.1.3 O4.1.2.1 to O4.1.2.5
O4.2	Strengthen institutional capacity in institutions involved in LULUCF by 2014	O4.2.1.1 to O4.2.1.3

Table 10 - LULUCF objectives and actions contained in the NCCAP (NCCAP, 2011)

➔ Other policies and strategies related to forestry

Forestry plans: Two Plans, 1973-1993 and 1990-2009, have been implemented, but “*there was no reference to or information on GHG mitigation policies and actions*” (NCCAP, 2011).

National Forest Programme (NFP): A “Forestry Sector Review” was finalised in 2001 with support from the World Bank and a NFP was finalised in 2004, but, again, “*the NFP does not have a direct reference to any policies and strategies for climate change and forestry*” (NCCAP, 2011)

Ninth Development Plan: It was finalised by the State Planning Organisation in 2006 and covered the period 2007-2013. Within this Plan, there were objectives indirectly related to LULUCF as a whole “*Achieving food security and safety and sustainable use of natural resources will be taken into account in creating an agricultural structure […] making efficient use of soil resources through the use of highly productive agricultural fields for agricultural production purposes, utilizing agricultural lands in line with their capabilities*” or forestry in particular “*Effective protection of the natural ecosystem of forests against fires and pests and its management in a multipurpose and efficient way*”.

National Afforestation and Erosion Control Mobilisation Law No.4122: It was enacted in 1995 to further encourage and support local communities, the private sector and State institutions and agencies in afforestation and erosion control activities, as well as to provide sustainable revenues to the Afforestation Fund.

National Afforestation and Erosion Control Action Plan: It was finalised by the OGM in 2008 and was aimed at; undertaking afforestation, rehabilitation and erosion control and rangeland rehabilitation works on 2.3 Mha, with a total budget of 20 MUS$/yr. The 41 MtCO2 of carbon stocks in degraded forests were expected to increase up to 222 MtCO2 and the total forest carbon stock to increase by 10%, up to 2,181 MtCO2eq (ASAN, 2010). The Plan also outlined that half of Turkey’s forests are degraded, out of which two third (around 7 Mha) could be rehabilitated, which means than the Plan only cover one third of the existing potential.

Forest Fire Fighting Programme: Under this Programme, the Government has developed a comprehensive real-time internet-based GIS for forests, which maps fires in all the country’s forest districts. This is linked to the fire control system, with information routed to fire fighting cells in the field through information dispatch centres. The budget of this Programme is 54 MUS$/yr.

Forest Pest Control Program: Under this Programme, mechanical, chemical, and biotechnical methods are employed by the OGM to control and fight pests. The budget of this Programme is around 2 MUS$/yr.

➔ Other policies and strategies related to agriculture soils (extracted from NCCAP, 2011)

Law No. 5403 on “Soil Protection and Land Use”: It provides the legal basis for the protection and sustainable use of soil.

Law No. 4342 on “Pastures Management”: It puts forth regulations for the identification, allocation and sustainable common use of pastures, prairies and meadows as well as increasing their productivity.

Zero-tillage programme: It promotes direct sowing using planters, without initial tillage. It has the double advantages to reduce energy consumption and increase soil organic matter content (and soil organic carbon content). The MFAL will provide 60TL/ha support for three years for 25,000 ha in different provinces.

Drainage Programme: Over 700 000 ha of the Harran Plain, in Şanlıurfa, can be observed high ground water levels, salinity, excessive sodium and alkalinity. Around 70 000 ha have been drained by 2012, which will certainly increase CO2 and non-CO2 gases emissions from the drained soils

➔ Foreseen changes in terms of AR and 1990-2020 data series for AR and D (Art. 3.3)

The OGM Strategic Action Plans aims at increasing the forest cover to 30% of the country (i.e. 23.5 Mha) by 2017. It foresees the following from 2013 to 2017: 500 000 ha of rehabilitation (obj. 2.2); 75 000 ha of natural regeneration (obj. 2.3); 65 000 ha of artificial regeneration (obj. 2.3); 150 000 ha of public afforestation (obj. 2.6); 50 000 ha of private afforestation (obj. 2.6); 393 400 ha of erosion control (obj. 2.8); and 50 000 ha of range improvement (obj. 2.8).

If we compile these figures into the **Excel sheet AR OGM** and apply the same rates of reclassification as previously presented (see **Part 3.1 supra**), then the 256 800 ha/yr of “raw” AR foreseen by OGM over 2013-2017 would convert into 122 872 ha/yr of “reclassified” AR over 2013-2017.

Taking into account an “informal” objective of 50 000 ha/yr of “raw” AR after 2017 up to 2020 (as expressed by the participants of the inception workshop to this study, February 2014) that would convert into 23 925 ha/yr of “reclassified” AR over 2018-2020, we can project rates of AR up to 2020: the average over 1990-2020 would then be 83 509 ha/yr.

In order to prepare the specific LULUCF calculations (see **Part 4.2 infra**), we then assume that AR species are selected in accordance with the current share in the forest, i.e. 81.3% of coniferous and 18.7% of deciduous in pure high forests (according to ENVANIS, 2014), and that they are distributed into two main management types: extensive (rehabilitation, erosion control, range rehabilitation, and energy forest) and intensive (public and private afforestation).

We then have four data series over 1990-2020: AR ext, con = 49 069 ha/yr, AR int, con = 18 816 ha/yr, AR ext, dec = 11 294 ha/yr, AR int, dec = 4 331 ha/yr. The cumulative of AR would then be 2 588 794 ha over 1990-2020 (see detailed data in **Excel sheet AR 3.3)**.

We then enter the AR data series into the **Excel sheet F 3.4 & D 3.3**. Knowing that the forest area (according to FAO definition) was 11 559 261 ha in 2011 (ENVANIS, 2012) and 9 679 614 ha in 1990 (FAO FRA, 2010), the net increase of forest cover was 1 879 647 ha over this period, or 85 439 ha/yr if we divide it by 22 years.

Knowing that the cumulative area of AR (calculated previously) is 1 909 908 ha over the same period, i.e. 86 814 ha/yr, then the difference 86 814 ha/yr – 85 439 ha/yr = 1 376 ha/yr can be estimated as the deforestation. Deforestation would in most cases be caused by degradation, with forest cover passing down the 10% threshold (pers. com. Dr. Yusuf SERENGIL, Istanbul University – May 2014).

As ENVANIS does not record deforestation area, even if OGM staff generally recognises its existence, we then apply this amount of deforestation conservatively over the remaining period, 2012-2020. The final result is as follows:

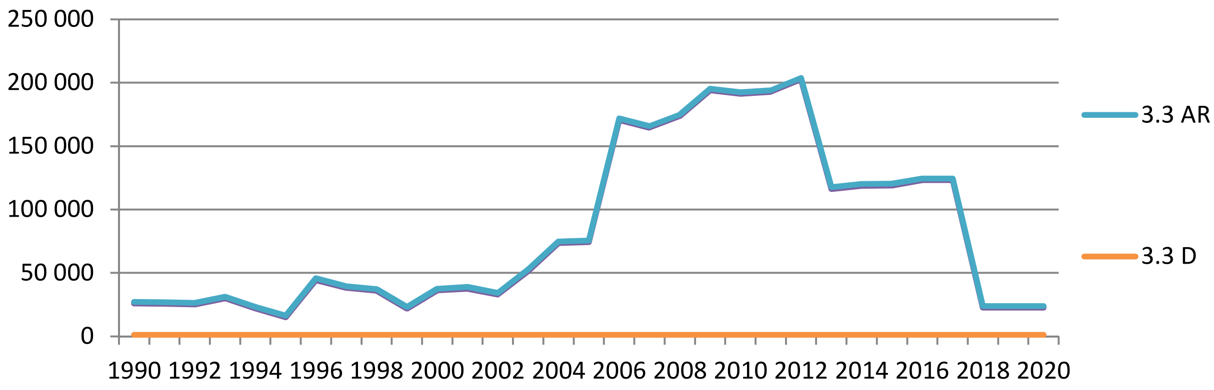

Figure 35 - Estimated 1990-2020 data series for 3.3 AR and 3.3 D (BOUYER, 2014)

➔ Foreseen changes in terms of forest area and 1990-2020 data series for FM (Art. 3.4)

Still working on the **Excel sheet F 3.4 & D 3.3** and in order to prepare the specific LULUCF calculations (see **Part 4.1 infra**), we estimate data series 1990-2020 of the main forest types to be considered under 3.4 FM. We proceed in four steps:

- Area of 3.4 FM. According to Articles 3.3 and 3.4 of the Kyoto Protocol, deforestation occurring after December 31, 1989 shall be accounted for under Art. 3.3. We then estimate the area to be considered under 3.4 FM by deducting deforestation from the initial 9 679 614 ha of forest in 1990. Therefore, the area considered under 3.4 FM is 9 638 348 ha in 2020, the deducted 41 266 ha from the initial area being equal to the deforestation over 1990-2020. We have a complete data series 1990-2020 for 3.4 FM area;
- Area of forest. We interpolate the data series 1990-2002 for the forest area, using the FAO FRA data for 1990 and the ENVANIS data for 2002. We estimate the data series 2013-2020 for the forest area by adding the net AR = AR-D over year, starting in 2012. We have a complete data series 1990-2020 for forest area;
- Areas of the main forest types. The three main forest types identified in ENVANIS are: high forest coniferous, high forest deciduous and coppices. Having the data series for these three forest types over 2002-2012, we extrapolate these data series back to 1990, and up to 2020. We have complete data series 1990-2020 for forest type area. The result is as follows:

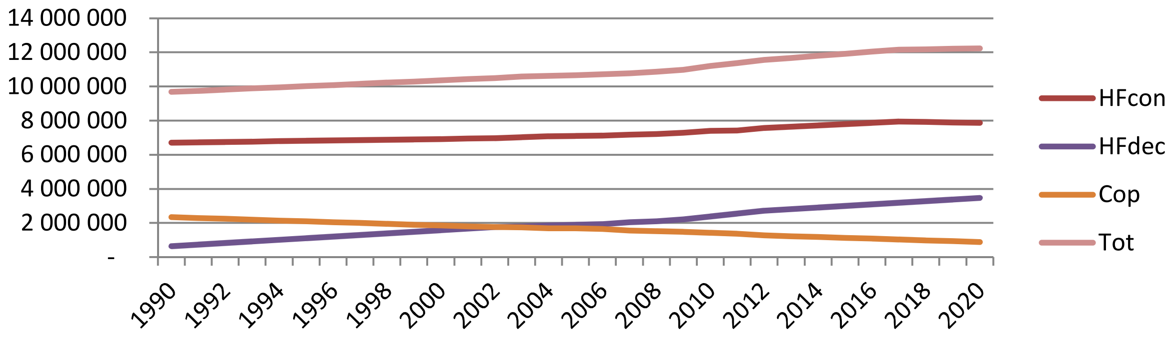

Figure 36 - Estimated 1990-2020 data series for forest area (ha), by forest types (BOUYER, 2014)

- Areas of 3.4 FM disaggregated by main forest types. Using the rule of three as follows: area for FM 3.4 forest type A = area for forest type A x (area for FM 3.4 / area for forest), we have complete data series 1990-2020 for FM 3.4 forest types area. The result is as follows:

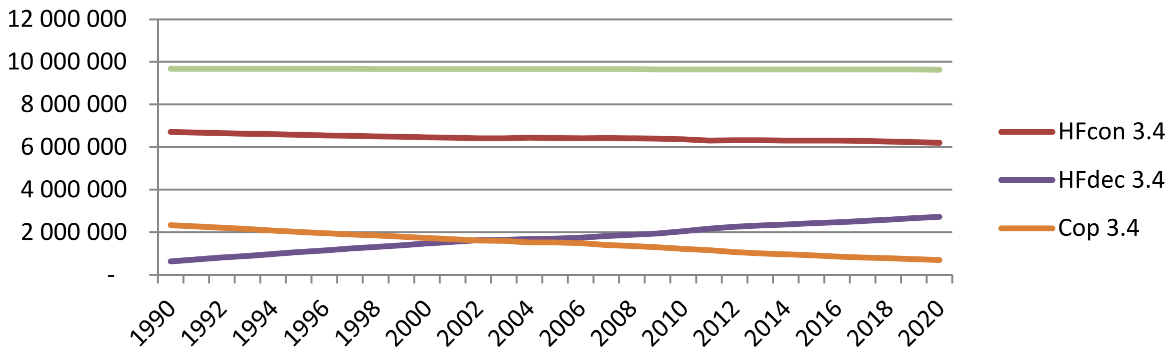

Figure 37 - Estimated 1990-2020 data series for 3.4 FM area (ha), by forest types (BOUYER, 2014)

➔ Foreseen changes in terms of stocks, volume increments, and dendrometric estimates

The 2002-2012 volume increment (Iv, in m3/ha/yr) for the three main forest types - high forest coniferous, high forest deciduous, coppices - can be deducted from ENVANIS data series (total volume increment in m3/yr and area per forest types in ha) (see detailed data in **Excel sheet Iv 3.3 & 3.4**). The results are as follow:

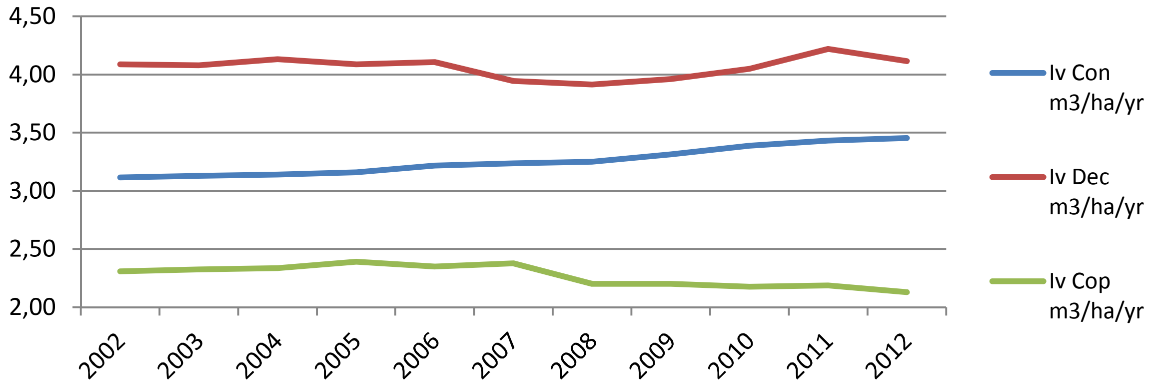

Figure 38 - 2002-2012 volume increment for the three main forest types (BOUYER, 2014, based on ENVANIS, 2013)

As there is no clear trend for high forest deciduous and coppices, Iv of these two forest types, for 1990-2001 and 2013-2020, are set equal to the average Iv minus its standard deviation (to be conservative) over 2002-2012. As there is a clearer trend for high forest coniferous, Iv data series for 1990-2001 and 2013-2020 are estimated by linear extrapolation of Iv data series for 2002-2012. The results are as follow:

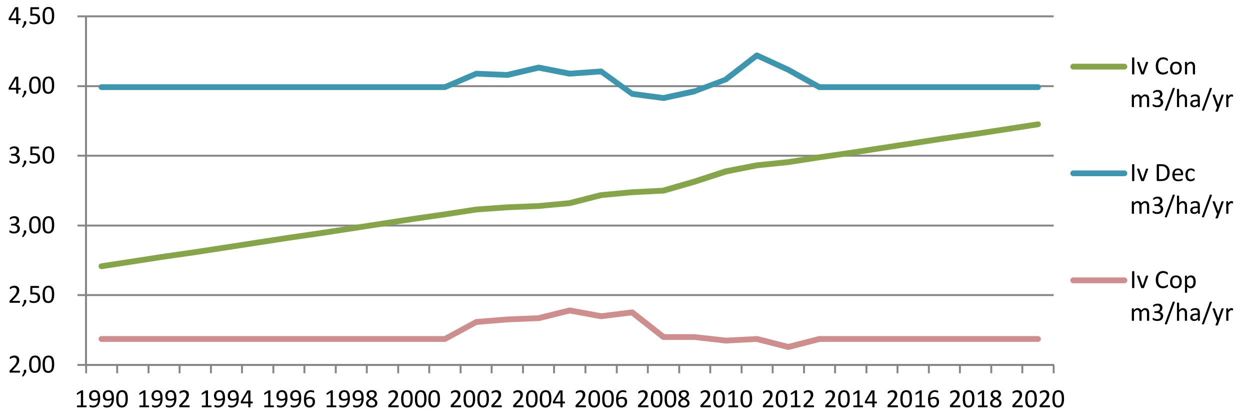

Figure 39 - 190-2020 data series of volume increment for the three main forest types (BOUYER, 2014)

In order to prepare the specific LULUCF calculations (see **Parts 4.1 and 4.2 infra** and see detailed data in **Excel sheet KP Const**), four dendrometric values have to be estimated: Basic Wood Density (D, expressed in tdm/3), Biomass Expansion Factor (BEF1 and BEF2, dimensionless), and Root-to-Shoot ration (R, dimensionless).

To allow refined estimates with country-specific values, we use ENVANIS data to identify the key forest species in Turkey. Ten of them are the main species in more than 98% of the Turkish forest:

Main species	Areas (ha)	Areas (%)
Calabrian pine	3 202 343	27,7%
Larch	2 564 720	22,2%
Oak	2 137 486	18,5%
Beech	1 621 257	14,0%
Scots pine	738 495	6,4%
Fir	406 498	3,5%
Spruce	228 786	2,0%
Cedar	220 328	1,9%
Alder	99 984	0,9%
Juniper	89 474	0,8%

Figure 40 - 10 top key species in Turkish forest (ENVANIS, 2013)

We then use the default values for D per specie, provided in Table 3.A.1.9-1 of the GPG LULUCF, 2003, apart for three species for which a default value is not provided. For these species, we use estimates provided in the literature: KIAEI, 2010 for Calabrian pine, http://www.simetric.co.uk/si_wood.htm for Cedar, and http://www.engineeringtoolbox.com/wood-density-d_40.html for Juniper.

This being done, we then estimate a "weighted" D for each of the three main forest types, coniferous, deciduous and coppices (mix), taking into account the specie specific D and the % of forest area per specie. We repeat the same approach for calculating "weighted" BEF1 and BEF2, based on default values provided per forest types and climatic zone in Table 3.A.1.10 of the GPG LULUCF, 2003.

Finally, for R, we use directly the default values provided per forest types and climatic zone in Table 3.A.1.8 of the GPG LULUCF, 2003. The results are as follow (in yellow are highlighted the deviation compared to the values used in the NIR 2013):

	D = Basic Wood Density (tdm/m3) - "weighted" per forest type		
0,422	Coniferous forest in Turkey	0,490	16%
0,577	Deciduous forest in Turkey	0,642	11%
0,475	Mixed forest in Turkey	0,542	14%
	BEF1 = Biomass Expansion Factor 1 (dimensionless) - weighted per forest type		
1,096	Coniferous forest in Turkey	1,220	11%
1,200	Deciduous forest in Turkey	1,240	3%
1,133	Mixed forests in Turkey		
	BEF2 = Biomass Expansion Factor 2 (dimensionless)		
1,300	Coniferous forest in Turkey	1,240	-5%
1,400	Deciduous forest in Turkey	1,26	-10%
1,334	Mixed forest in Turkey	na	na
	R = Root to Shoot Ratio (dimensionless) (defaut values, GPG Table 3A.1.8)		
0,32	Coniferous forest		
0,26	Deciduous forest		
0,29	Mixed forest		

Figure 41 - Estimates of D, BEF1, BEF2, and R for Turkish forests (BOUYER, 2014)

Using the estimates for D (in tdm/m3) and BEF1 (dimensionless) per main forest types, and the stocks (in m3/ha) reported in the NFI for 1972 and 2004 (useful only for coppices, as the NFI 1972 and 2004 did not report specifically the stocks and areas for coniferous and deciduous forests) as well as the ENVANIS database for 2011, we estimate the stocks (in tdm/m3) with the following equation: S(tdm/ha) = S(m3/ha) x D x BEF1.

The results are as follow:

	NFI 1972	NFI 2004	ENV 2011	Defaut value Table 3A.1.2	Value retained
S (m3/ha) in Hfcon (ENVANIS)			121,6		
S (tdm/ha) in Hfcon			56,2	134	56,2
S (m3/ha) in Hfdec (ENVANIS)			145,4		
S (m3/ha) in Hfdec			100,6	122	100,6
S (m3/ha) in Cop (ENVANIS)	33,0	41,9	41,0		
S (m3/ha) in Cop	17,7	22,5	22,0	128	18,8

Figure 42 - Estimates of stocks (in tdm/ha) for the three main forest types (BOUYER, 2014)

We compare these values with the default values provided in the Table 3A.1.2 of the GPG LULUCF 2003 for coniferous, deciduous and mixed forest above 20 years in temperate regions. All the default values are above (and even well above for coniferous and mixed forest) the country specific values, which is understandable, knowing that Turkish forest are quite degraded. We therefore retain the country specific values.

After that, we use these estimated stocks together with the estimated data series of 3.4 FM areas for the three main forest types (see in this **Part 3.4 supra**) and use them to estimate the 1990-2020 data series of average stock in Turkish forest, taking into account the respective stocks and evolution of areas for the three main forest types. The result is as follows. It is worth noting that the average stock is estimated to increase by 24% from 1990 (50.1 tdm/ha) to 2020 (66.1 tdm/ha), i.e. 0.8%/yr.

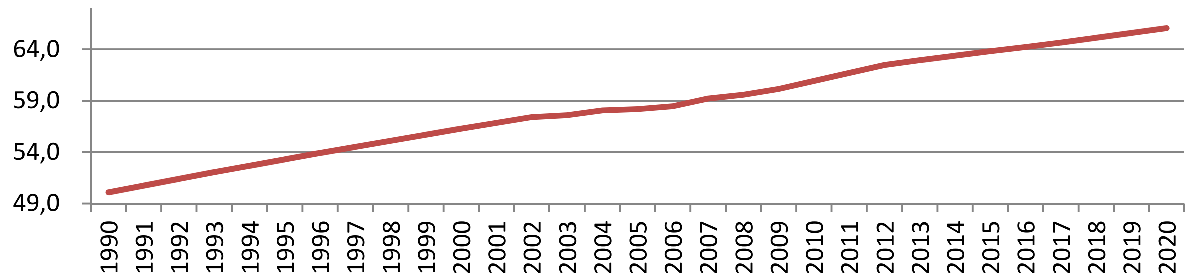

Figure 43 - 1990-2020 data series of the average stocks (tdm/ha) in Turkish forests (BOUYER, 2014)

➔ Foreseen rate of harvest

In what follows, we will mainly concentrate on 3.4 FM. Indeed, harvest in AR made after December 31, 1989 – to be considered under 3.3 AR - are very limited: the first thinning comes at best after 15 to 20 years and only 15 to 40% of the trees are harvested (pers. com. Ugur TUFEKCIOGLU - Head of the Forest Maintenance Division of OGM, February 2014). Therefore, in the calculations made for 3.3 AR (see **Part 4.2 infra**), we will consider a uniform thinning of 20% of the trees after 15 years, which appears a conservative assumption.

Coming back to 3.4 FM, two options are considered in what follows:

- Extensive scenario. Only considering the effective thinning of forests, according to the management plans prescriptions, an increase of total roundwood production of 25 Mm3 by OGM would be possible by 2020. It would imply an intermediate objective of 21 Mm3 by 2017 (pers. com. Ramazan BALI - Head of Wood Marketing Division, February 2014);
- Intensive scenario. According to the OGM Strategic Plan 2013-2017, the previous Strategic Plan 2010-2014 envisaged to increase the industrial roundwood production by OGM to 90 Mm3 over 2010 and 2014 (i.e. 18 Mm3/yr). However, the production fell short of the objective. Even though no numeric figure exists in the OGM 2013-2017 Strategic Plan, the same increase (18 Mm3/yr) is still envisaged for 2013-2017 (pers. com. Alper Tolga ARSLAN – Head of Strategic Planning and Research Strategy Division, Department of Strategic Development of OGM, February 2014). This figure is not included in the current Strategic Plan because production will ultimately depends on market conditions and OGM staff did not want this objective to be set in stone.

In the extensive scenario (see detailed data in **Excel sheet Vfell Ext OGM**), we could estimate the following:

- Firewood. Illegal harvest, private sector production and consumption would follow linear trends (extrapolation from the respective historical data series). Import-export, already very reduced, could be assumed to be nil. Then, we would assume OGM harvest of firewood is set to match consumption with production. The OGM harvest of firewood would then be 2.6 Mm3/yr by 2020. Here below are the projections (expressed in '000 m3/yr):

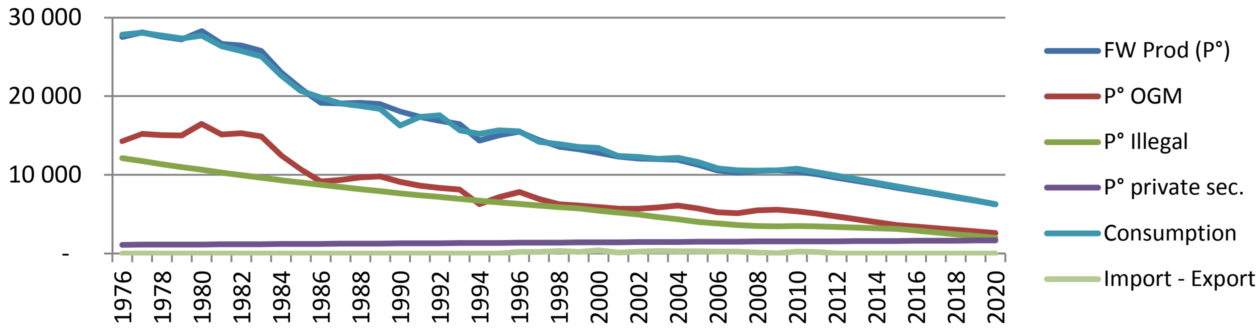

Figure 44 - 2020 projections of firewood production and consumption in the extensive scenario (BOUYER, 2014)

- Roundwood. Illegal harvest and private sector production would follow linear trends (extrapolation from the respective historical data series). OGM harvest is supposed to be 21 Mm3 in 2017 and 25 Mm3 in 2020 (harvest for the years in between is estimated by interpolation). The total production is known (illegal harvest + private sector + OGM). The consumption would follow linear trend (extrapolation from the historical data series). Import-export is then estimated by deducting production to consumption. Here below are the projections (expressed in '000 m3/yr):

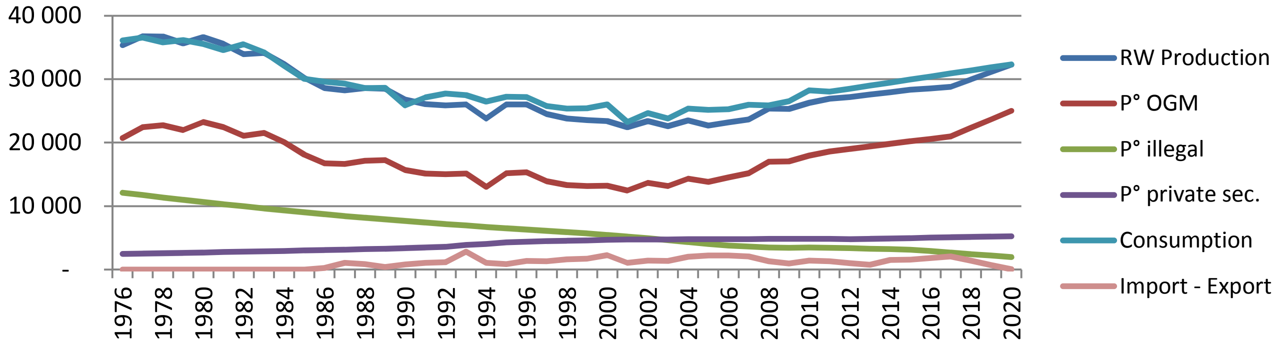

Figure 45 - 2020 projections of roundwood production and consumption in the extensive scenario (BOUYER, 2014)

- Industrial roundwood. Private sector production would follow a linear trend (extrapolation from the respective historical data series). Illegal harvest would be nil (as already assumed by OGM). OGM harvest of industrial roundwood is the difference between its total harvest and its firewood harvest. Consumption of industrial roundwood is the difference between total consumption and firewood consumption. The production is estimated by adding OGM production and private sector production. Import-export of industrial roundwood is equal to total import-export (import-export of firewood being nil). Here below are the projections (expressed in '000 m3/yr):

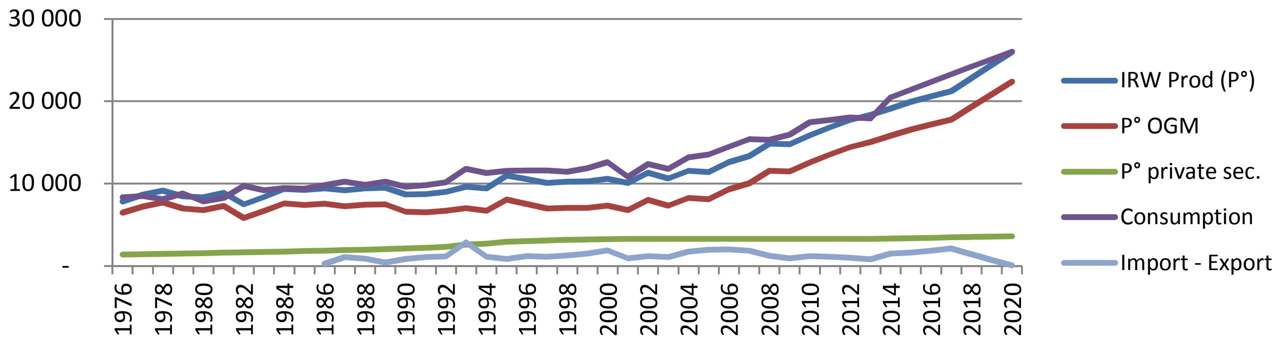

Figure 46 - 2020 projections of ind. roundwood production and consumption in the extensive scenario (BOUYER, 2014)

In the intensive scenario (see detailed data in **Excel sheet Vfell Int OGM**), we could estimate the following:

- Firewood. The sub-scenario remains the same as in the extensive scenario (the increased production does not has consequence to the domestic demand, which is inelastic to the offer);
- Roundwood. 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 Mm3 in 2013, 16 Mm3 in 2014, 18 Mm3 in 2015, 20 Mm3 in 2016, 21.3 Mm3 in 2017 (90 Mm3 in total). After that, we assume the same trend will continue up to 26.4 Mm3 by 2020.

  Knowing OGM levels of production of industrial round wood and firewood, its total production of roundwood is known. Then, assuming private sector production of roundwood would follow a linear trend (extrapolation from the historical data series) and knowing that the illegal sector production of roundwood is equal to its production of firewood, the total production of roundwood is known by adding the levels of production of OGM + private sector + illegal harvest.

  Then, assuming the consumption of roundwood would follow a linear trend, import-export is deducted by subtracting the production to the consumption. It is worth noting that, under this intensive (and ambitious) scenario, Turkey is assumed to be net exporter of roundwood. Here below are the projections (expressed in '000 m3/yr):

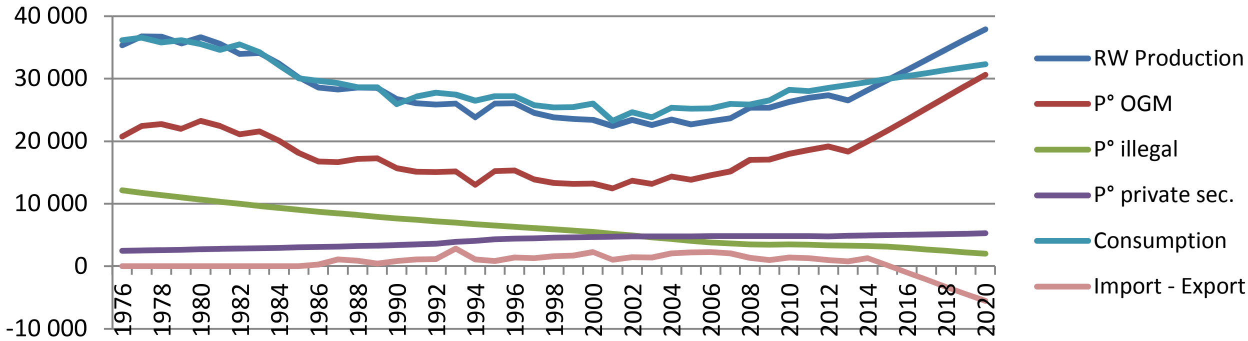

Figure 47 - 2020 projections of roundwood production and consumption in the intensive scenario (BOUYER, 2014)

- Industrial roundwood. The estimate of OGM production of industrial roundwood has been explained above. Import-export of industrial roundwood is equal to total import-export (import-export of firewood being nil). Private sector production of industrial roundwood is the difference between its total harvest and its firewood harvest. Consumption of industrial roundwood is the difference between total consumption and firewood consumption. The production is estimated by adding OGM production and private sector production. Here below are the projections (expressed in '000 m3/yr):

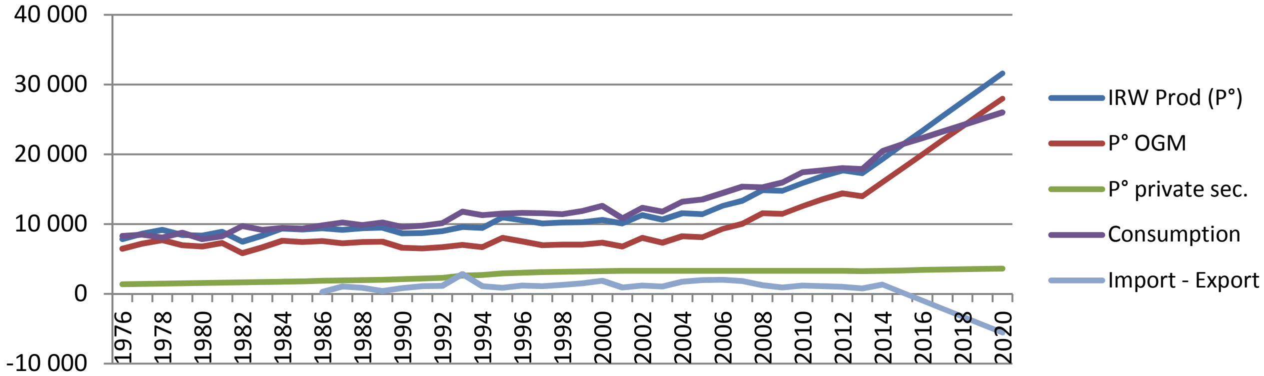

Figure 48 - 2020 projections of ind. roundwood production and consumption in the intensive scenario (BOUYER, 2014)

Having estimated two 1990-2020 data series of roundwood production for OGM, an extensive one (25 Mm3/yr by 2020) and an intensive one (29 Mm3/yr by 2020, + 4 Mm3/yr compared to the other), we then allocate this harvest to the three main forest types (see detailed data in **Excel sheets Vfell-Int 3.4 and Vfell-Ext 3.4**).

Indeed, we know the allowable cut for 2002-2012 (ENVANIS, 2013), which is spread between high forest coniferous and high forest deciduous (99.9% of industrial roundwood. Therefore, harvest of firewood in high forest is neglected, to simplify the calculations) on the one hand, coppices (100% of firewood) on the other hand. We also estimate a 3% difference in average over 2002-2012, between allowable cut and real cut (the last one being lower) and we therefore assume the two are equal to simplify the calculations.

Then, we extrapolate the shares (in %) of total harvest for the three main forest types in 1990-2001 and 2013-2020, using 2002-2012 ENVANIS data. After that, we allocate the estimated 1990-2012 data series of harvest, using the estimated % of harvest for each forest types. The results are as follow (expressed in '000 m3/yr):

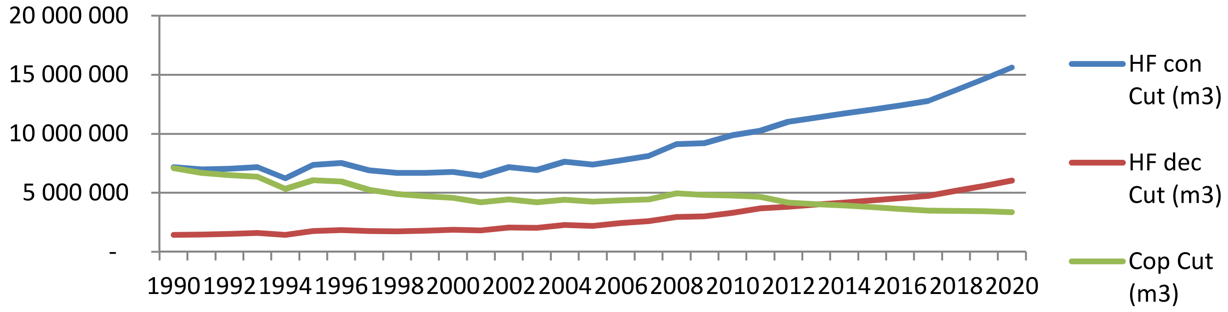

Figure 49 - 2020 projections of harvest per forest types in the extensive scenario (BOUYER, 2014)

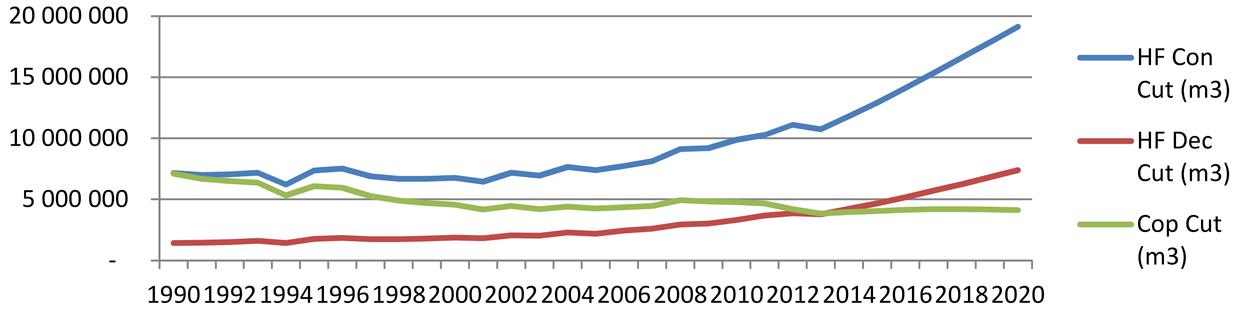

Figure 50 - 2020 projections of harvest per forest types in the intensive scenario (BOUYER, 2014)

➔ Focus on the foreseen rate of firewood harvest

At the inception workshop to this study, there was a debate about the development of bioenergy and its possible impact in terms of harvest. Indeed, in addition to the use of "traditional" firewood by forest villagers and the rural population in general, some documents pointed out the potential development of pellets to be use in industrial power plant:

- "*As a result of the wood energy initiatives, it may increase again in the future […] wood energy activities have been further encouraged within the framework of the adaptation and mitigation efforts for climate change. For this purpose, OGM experts prepared a report on "The Status of Forest Biomass in Renewable Energy" […] and OGM organized a workshop on "Forest biomass and bioenergy*" (HAASE – FAO, 2011). During this workshop held in Kastamonu, in February 2010, the OGM declared that "*we expect that much of the extra 5 Mt/yr of production will be available as forest residues fuel*" (Flyer Kastamonu, 2010). It is difficult to use this last figure, since it is expressed in relative term ("extra") and since the "baseline" level is not précised;
- The 2020 projection for final energy consumption (BALANCE) presented in the First National Communication (NC1, 2007), assumes that the share of renewable energy will increase from 6.9 to 9.3 Mtoe, and that the share of woody biomass is expected to decrease from 5.7 to 3.9 Mtoe, e.g. 8.58 Mtdm in 2020 (using a usual conversion factor of 2.2 tdm/toe).

Using this last official projection and taking into account the assumptions already presented (see **<u>Part 3.1 supra</u>**: shares of forest types in productive forests, default values for the BCEF from Table 5.4 of the FAO FRA 2010 Guidelines), firewood harvest in 2020 can be estimated in the main forest types: 6.73 Mm3 (8.58 Mtdm x 59% x 1.33 tdm/m3) in coniferous forests; 1.55 Mm3 (8.58 Mtdm x 19% x 0.95 tdm/m3) in deciduous forests; 2.25 Mm3 (8.58 Mtdm x 23% x 1.14 tdm/m3) in mixed forests.

In total, the BALANCE projection leads to a total firewood harvest of 10.53 Mm3/yr in 2020, i.e.67% more than the projections made under the intensive and extensive scenarios (see detailed data in **<u>Excel sheets Vfell-Int OGM and Vfell-Ext OGM</u>**).

According to inception workshop participants, the BALANCE projection is no more pertinent. Indeed, the Scientific and Technical Research Council of Turkey (TUBITAK) carried out a feasibility study about the development of industrial biomass plant. This study concluded that electricity production from forest biomass is only feasible for plants over 20 MW. But, OGM realised it is logistically and economically not feasible to provide such large amount of biomass: OGM was initially looking for plants of one to two MW. Therefore, the pilot plant foreseen in the TUBITAK project was not installed and the objective of developing an industrial biomass value chain was abandoned.

➔ Biotic and abiotic damages

We can consider the consequences of these damages on biomass growth, on the one hand, and biomass loss, on the other hand:

- <u>Biomass growth:</u> As the growth of productive forest area affected by all biotic (pests and diseases) and abiotic (storm, avalanche, snow, flooding, forest fire) damages is reported together with the growth of the non-affected area in ENVANIS, the decrease of forest growth due to these damages is captured in the historical ENVANIS data series;
- <u>Biomass loss:</u> as explained previously, for most of the abiotic damages and for biotic damages (excluding forest fires), salvage logging is carried out. Therefore, for these damages, feeling and/or firewood (biomass loss) is already incorporating in the ENVANIS and Wood Marketing Department data series.

Therefore, we will only concentrate on the projection of forest fires by 2020, in order to latter estimate the related biomass loss (see **<u>Part 4.1 and 4.2 infra</u>**). This exercise is difficult and subject to discussion, since some of the factors determining the impacts of forest fires can be controlled and other not. For instance,

- The number of forest fire starts due to negligence might be reduced by increasing information and prevention measures, but will have poor effect on criminal forest fires;
- The stopping of forest fires in the crucial first 20 minutes can be improved by using up a real-time fire alert system (as does OGM) and making sure the firemen are on site as fast as possible;
- Whatever efforts are made in terms of prevention, fire alert system, forest firefighting equipment, etc. will not allow avoiding large forest fires if the natural conditions are conducive (e.g. firemen often refer to the rule of the “3x30”: in case air humidity is below 30%, wind speed above 30 km/hr, and ground temperature above 30°C, there are few chances to stop a forest fire).

This being said, we forecasted the forest fires as follow (see detailed data in **<u>Excel sheet Fire 3.3 & 3.4</u>**):

- <u>Area per fire:</u> the average area is 4.6 ha/fire over 2000/2012. This rate could be reasonably decreased to 2.5 ha/fire by 2020 (pers. comm. Ugur BATTACI - Meteorology Division of Forest fire Department of OGM, February 2014, corroborated by pers. com. Alper Tolga ARSLAN – Head of Strategic Planning and Research Strategy Division, Department of Strategic Development of OGM, February 2014). Then, the area per fire for 2013-2020 can be interpolated, using 4.6 ha/fire as a reference value in 2012 and 2.5 ha/fire as an objective by 2020;
- <u>Number of fire:</u> the number of fire over 2013-2020 is set equal to the average over 2000-2012, i.e. 2 072 fires/yr.
- <u>Area burnt:</u> the area burnt is equal to area per fire x number of fires. It decreases over time, up to 5 180 ha in 2020. The average over 2013-2020 is 7 063 ha, which is 28% below the average over 2000-2012 (9 834 ha). The projection seems ambitious, but looking at the progress made in the last two decades by the Forest Fire Fighting Department of OGM, it seems achievable.

3.5. Summary: State of LULUCF in Turkey and key changes foreseen by 2020

Within the Ministry of Forest and Water Works (MFWW), the General Directorate for Forestry (OGM) is the main responsible for the management of forest. According to the national definition, there is around 21.7 Mha of forest (27% of Turkey), 53% considered "productive" (above 10% of forest cover) and 43% considered "degraded" (between 1% and 10% of forest cover).

There are several concerns about the identification of "forest land" in the LULUCF reporting for the Climate Convention: Inclusion (or not) of "unmanaged forest"? Coherence between "legal boundary" (cadastre) and "technical boundary" (management plan)? Consideration of private afforestation? But, first and foremost, there is a concern about the use of the national definition, which is not in line with the FAO definition, and consequently, with a potential definition of forest under the Kyoto Protocol.

The study therefore uses the FAO definition to identify and triangulate historical data series related to the forest area, including afforestation/reforestation, the biomass stock and volume increment, the harvest (felling and firewood), the forest fires, other biotic (insects, pests, diseases) and abiotic (storms, avalanches, flooding, etc.) damages.

Overall, an impressive improvement of the Turkish forests 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 felling since the 2000's.

Turkey started reporting LULUCF under the Climate Convention in 2006. Presently, the LULUCF sink (made of the forest sink for its bigger part) is estimated to offset 12% of the total greenhouse emissions of Turkey.

However, this figure is to be considered cautiously, since weaknesses and shortcomings were identified in the last LULUCF inventories: absence of a key category analysis, use of low Tier for certain categories suspected to be keys, inconsistency between the land use representation for forest (based on the ENVANIS database,) and for agriculture (based on Corine Land Cover), lack of a coherent quality analysis/ control system, lack of transparency for certain data or assumptions, etc.

Based on that, it was considered preferable to compile all the historical activity data series available and to project these activity data up to 2020, based on the foreseen changes in the LULUCF sector in Turkey (afforestation, harvest, forest fire fighting, etc.). In parallel, the emission factors and key dendrometric variables (stocks per forest type, volume increments, basic wood densities, biomass expansion factors, etc.) were reviewed.

For afforestation/reforestation (Article 3.3.), the objectives of the 2014-2017 OGM Strategic Plan were considered. For forest management (Article 3.4), two alternative scenarios were considered: 90Mm3 of roundwood harvest between 2013 and 2017 (intensive harvest) and 25 Mm3/yr of felling (industrial roundwood) harvest by 2020 (extensive harvest). The corresponding volumes of firewood, felling and total roundwood were forecasted accordingly from 2013 to 2020.

In terms of biotic and abiotic damages, a specific focus was put on forest fire and the associated biomass losses were forecasted from 2013 to 2020. The decrease of biomass loss and the increase of biomass loss associated with the other damages were assumed to be already captured in the ENVANIS database and the Wood Marketing database.

4. Estimation of costs-benefits of LULUCF policies & measures

4.1. Credit vs debit for Art. 3.4 - FM

➔ Overview of calculations to estimate the 1990-2020 net removals in 3.4 FM area

Using estimates calculated previously (see **Part 3.4 supra**), we will first estimate the net-removals in the 3.4 FM area for the entire time series, considering the two scenarios of harvest, intensive (29 Mm3/yr by 2020) and extensive (25 Mm3/yr by 2020). To do so, we follow the guidance of the GPG LULUCF 2003, set in Chapter 3, Part 3.2.1 (see detailed data in **Excel sheets 3.4-Ext and 3.4-Int**)

The central equation is the Equation 3.2.1: ΔCFF = ΔCFF(LB) + ΔCFF(DOM) + ΔCFF(SOC), where ΔCFF is the carbon stock change in forest remaining forest, disaggregated in carbon stock changes for different carbon pools:

- Living Biomass (LB), itself comprising two carbon pools: Above Ground Biomass (AGB) and Below Ground Biomass (BGB);
- Dead Organic Matter (DOM), itself comprising two carbon pools: Litter and Dead Wood. The Harvested Wood Pool (HWP) can be considered as another pool under DOM. We will come back to it latter;
- Soil Organic Carbon (SOC)

As (i) the carbon soil map is considered poorly reliable for forest land (pers. comm. from Mrs Selda PAS - GIS Division of the Information System Department of OGM, February 2014) and (ii) geolocation of forest land according to climatic zones, soil types and management regimes (NB: three factors implied in soil carbon fluxes) is difficult with the current data organisation of ENVANIS, it is assumed here that the SOC pool is not a source in forest remaining forest, which might be true in most part of the forest area (97% of mineral soils in Turkey according to TURKSTAT; general efforts of OGM to rehabilitate degraded forests and, thus, contributing to increasing the SOC pools)

As for dead wood and litter, to our best knowledge, there is no country-specific data, which makes it hazardous to assume a certain % of biomass is let to decay in forest remaining forest. Therefore, to be conservative, we will assume all the harvested biomass left in the forest after felling or firewood collection is instantaneously oxidised. We further assume that these two carbon pools are not source, taking into account the fact that dead wood collection and grazing in OGM-managed forests are closely controlled by the “forests chiefs” (field agent of OGM, in charge of implementing the forest management plans).

Based on the above, we focus our calculations on LB, estimating LB growth on the one hand, and LB loss due to felling, firewood collection and other losses on the other hand. As there are few country-specific data, we use the default approach, called “Gain-loss approach” (the alternative one being the “Stock change approach” and requiring very accurate and repeated forest inventory, which is not the case in Turkey). This approach is summarised by Equ. 3.2.2: ΔCFF(LB) = ΔCFF(G) - ΔCFF(L), where G = Growth and L = Loss.

In terms of other losses, as explained previously (see **Part 3.4 supra**), we concentrate on forest fires, one of the few biotic and abiotic damages which does not allow salvage logging. Indeed, for the other biotic (pests and diseases) and abiotic (storm, avalanche, snow, flooding) damages, the biomass gains and loss are taken into account in the general data series:

- Forest growth: the growth of productive forest area affected by all damages is reported together with the growth of the non-affected area in ENVANIS. Therefore, the decrease of forest growth due to these damages is captured in the historical data series (NFI and ENVANIS);
- Forest loss: salvage logging is carried out and the corresponding feelings and/or firewood is already incorporating in the ENVANIS and Wood Marketing Department data series.

➔ Estimating biomass growth in 3.4 FM area

Following the Gain-loss approach, we estimate biomass growth using Equ. 3.2.4: ΔCFF(FG) = Σ (Ai x Gi) X CF, where

Ai = Area of forest type i (in ha). In our case, as presented earlier (see **Part 3.4 supra**), we distinguished three main forest types: high forest coniferous, high forest deciduous, and coppices.

CF =: Carbon Fraction (tC/tdm), based on default value of 0.5 tC/tdm according to p3.25 of GPG LULUCF 2003.

Gi = Growth of forest type i (in tdm/ha/yr). Gi refers to the Equ. 3.2.5: Gi = Iv x D x BEF1 x (1 + R), where Iv = Volume Increment (m3/ha/yr), D = Basic Wood Density (tdm/m3), BEF1 = Biomass Expansion Factor (dimensionless), R = Root-to-Shoot ratio (dimensionless). All these variables were presented and calculated earlier (see **Part 3.4 supra**)

➔ Estimating biomass loss in 3.4 FM area

Following the Gain-loss approach, we estimate biomass loss using Equ. 3.2.6: ΔCFF(L) = Lfelling + Lfuelwood + Lother loss, and the related Equations:

- Felling. Equ. 3.2.7: Lfelling = H x D X BEF2 X (1 - Fbl) X CF, where H = Harvest of industrial roundwood (m3/yr), D = Basic Wood Density (tdm/m3), BEF2 = Biomass Expansion Factor (dimensionless), Fbl = Fraction of biomass left as dead wood (dimensionless), and CF = Carbon Fraction (tC/tdm). Apart from Fbl, all these variables were presented and calculated earlier (see **Part 3.4 supra**).

  As presented earlier in this part, dead wood is considered to be instantaneously oxidised (conservative assumption) and Fbl is therefore set to 0. BEF2 is used with Volume Over Bark (VOB), but ENVANIS and Wood Marketing databases report felling in Volume Under Bark (VUB). Therefore, a conversion was made as follows: VOB = VUB/0,85, according to page 3.29 of GPG LULUCF 2003.

- Firewood. Equ. 3.2.8: Lfuelwood = FG x D X BEF2 X CF, where FG = Firewood Gathering (mm3/yr), D = Basic Wood Density (tdm/m3), BEF2 = Biomass Expansion Factor (dimensionless), and CF = Carbon Fraction (tC/tdm). All these variables were presented and calculated earlier (see **Part 3.4 supra**).

- Other loss. Equ. 3.2.9: Lother losses = Adisturb x Bw X (1 - Fbl) X CF, where Adisturb = Areas affected by disturbances (ha/yr), Bw = Biomass stock in forests (tdm/ha), (1-Fbl) = ratio of biomass loss due to the disturbance (dimensionless), and CF = Carbon Fraction (tC/tdm). Apart from (1 - Fbl), all these variables were presented and calculated earlier (see **Part 3.4 supra**).

  As said earlier, only forest fires are here considered and subdivided into

  - Crown fire. 72.2% of forest fires, according to the observed ratio in 2013. For crown fires, we use 1 – Fbl = 0.45, according to default value from the same Table 3A.1.12;
  - Ground fire. 27.8% of forest fires. For ground fires, we use 1-Fbl = 0.15, according to default value from Table 3A.1.12 (taking the same assumption as for boreal forest: 1/3 of (1-Fbl) of crown fire).

  Last but not the least, we also spread the 1990-2020 area of forest fire between Art. 3.4 FM and Art. 3.3 ARD, proportionally to the respective areas considered every year under 3.3 and 3.4.

  Finally, as non-CO2 gases are also emitted during biomass combustion, we estimate them using Equ. 3.2.19: N-CO2 em = C em x (CH4 Erat X 16/12 + CO Erat x 28/12 + N/C x N2O Erat x 44/28 + NOx Erat x N/C x 46/14, where N-CO2 em = emissions from other GHG (in tC/yr), C em = the result from Equ. 3.2.9 (tC/yr), Erat = Emission ratio (dimensionless), and N/C = ratio carbon/nitrogen (dimensionless).

  For Erat, the following default values from Table 3.A.1.15 are used: CH4 Erat = 0.012, CO Erat = 0.06, N2O Erat = 0.007, NOx Erat = 0.121. Lastly, the N/C ratio is taken according to page 3.50 of GPG-LULUCF 2003: 0.01

➔ Net removals from Harvesting Wood products (HWP) with intensive vs extensive harvest

As presented earlier (see Part 2.3 supra), the current LULUCF accounting rules allow for the reporting and accounting of carbon stock changes in HWP. In order to estimate these changes, we use the general method explained in Equ. 12.1 of the AFOLU 2006 guidelines (the GPG LULUCF 2003 present three alternative approaches, that were further refined in the AFOLU 2006 guidelines):

C(i+1) = exp(-k) x C(i) x [(1-exp(-k))/k] x 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)

ΔC(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 use the following default values for our calculations:

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

Figure 51 - Default values used to estimate carbon stock changes in HWP pool (IPCC, 2006)

We do these calculations in four steps:

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

  Comparing UNECE data series and OGM data series for industrial roundwood over 1976-2011 (starting date for OGM data series), we notice 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 correct 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 use the corrected 1964-2011 data series and we extrapolate 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 have complete 1900-2011 data series for all the categories;

- Share of HWP categories over 2012-2020: We estimate 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 are not considered in the analysis, either because they are short-lived products or marginal or difficult to estimate). For each scenarios, intensive vs extensive, we disaggregate the 2012-2020 volume of industrial roundwood into the two HWPs, using the calculated %;

- Inflow of HWP over 1900-2020: We multiply the four data series (two scenarios x two HWPs) expressed in '000 m3/yr by the "weighted" Basic Wood Density factor (D, tdm/m3) calculated for mixed forest in Turkey (see detailed data in **Excel sheet KP Const**);

- Carbon stock and carbon stock changes in HWP: For each data series, we apply the Equ. 12.1, using the ad hoc default values presented. The result is as follow, in MtCOeq/yr of net removals from HWP, with the intensive scenario in blue and the extensive in red:

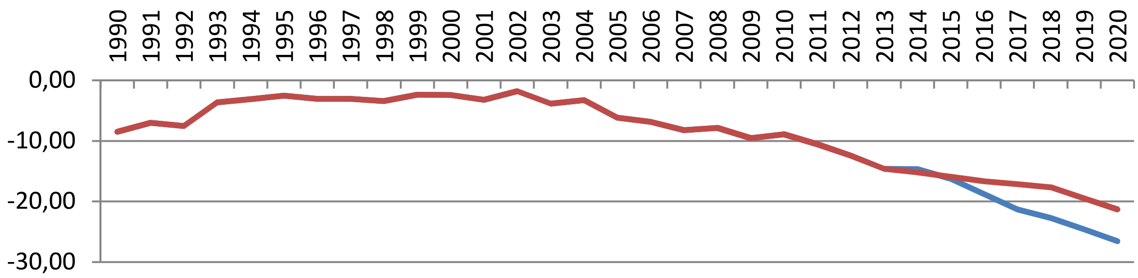

Figure 52 - Net removals from HWP (MtCO2eq/yr) under intensive vs extensive scenario (BOUYER, 2014)

NB: There is no double counting of "HWP credits" and "natural disturbances discounting". Indeed, the force majeure clause is not used in the calculations, as most of the wood remaining on the forest after fires, storms, etc. is subject to salvage logging.

➔ 1990-2020 net removals in 3.4 FM area under two scenarios, intensive vs extensive harvest

Having done all our calculations, we can estimate net removals including HWP for the 1990-2020 time series for the two scenarios. The results are as follow, expressed in MtCO2eq/yr of net removals (see detailed data in **Excel sheet CCL 3.4**):

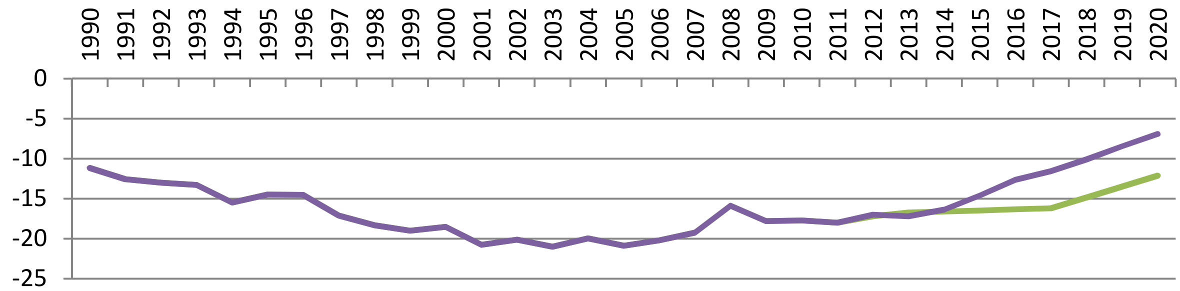

Figure 53 - 1990-2020 net removals in 3.4 FM area under intensive vs extensive scenario (BOUYER, 2014)

Based on these results, and taking into account the upgraded LULUCF accounting rules for Art. 3.4 FM (see **Part 2.3 supra**) as well as the "*Synthesis Report of the Technical Assessments of the Forest Management Reference Level (REL) Submissions*" published in November 2011 by the UNFCCC Secretariat, we can envisage five different manners to interpret the elements of footnote 1 in Annex of 16/CMP.1 in order to set the REL for Art. 3.4 FM in Turkey:

All numbers in MtCO2eq	**Number of**	**Corresponding**	**Difference if**		**Removal Units**	
Choice of REL	**Annex 1 Parties**	**REL in Turkey**	**Int. Scen.**	**Ext. Scen.**	**Int. Scen.**	**Ext. Scen.**
2020 projections	31 (incl. 24 EU States)	-235,7	0,0	-46,5	-	46,5
Historical 1990	3 (Belarus, Norway, Russia)	-157,0	-78,7	-125,2	52,8	52,8
Average 1990-2009	1 Greece	-176,2	-59,5	-106,0	52,8	52,8
Linear trend 1900-2008	2 (Cyprus and Malta)	na (no linear trend)			-	-
0	1 (Japan)	0	-235,7	-282,2	52,8	52,8
1990 GHG emissions in Turkey excl. LULUCF (tCO2eq/yr)		188,4		Cap of 3.5%	-52,8	

Figure 54 - Five different RELs for Art. 3.4 FM in Turkey and numerical consequences (BOUYER, 2014)

The five proposed RELs are possible. In particular, a 2020 projection based on the intensive scenario in terms of harvest rate would be defensible, since it was publicly announced before 2009, during the preparation of the OGM Strategic Plan 2010-2014: as such, this harvest rate can be considered as part of the projected REL (see **Part 2.3 supra** for explanations about the elements of footnote in Annex of 16/CMP.1).

4.2. Credit vs debit for Art. 3.3 - ARD

➔ Overview of calculations to estimate the 1990-2020 net removals associated with 3.3 ARD

Using estimates calculated previously (see **Part 3.4 supra**), we will first estimate the net-removals associated with 3.3 ARD for the entire time series. To do so, we follow the guidance of the GPG LULUCF 2003, set in Chapter 3, Part 3.2.1 (see detailed data in **Excel sheet 3.3**)

The two central equations are:

- Equation 3.2.21: ΔCLF = ΔCLF(LB) + ΔCLF(DOM) + ΔCLF(SOC), where ΔCLF is the carbon stock change in non-forest land becoming forest (with disaggregation into different carbon pools. See **Part 4.1 supra**);
- Equation 3.4.13: ΔCF-NF, LB = Aconversion x (Cafter-Cbefore + Δcgrowth), where ΔCF-NF is the carbon stock change in forest becoming non-forest, Cafter is the carbon stock in non-forest (conservatively assumed to be 0, in the absence of geolocation of deforestation), Cbefore the carbon stock in forest, and ΔCgrowth is the carbon stock increase due to subsequent biomass increase (conservatively assumed to be 0, in the absence of geolocation of deforestation).

As for 3.4 FM, we will not consider the DOM and SOC pools, assuming they are not source. Based on the above, we focus our calculations on LB, estimating (i) for AR: LB growth on the one hand, and LB loss due to felling, firewood collection and other losses on the other hand, (ii) for D: LB loss due to deforestation. As for 3.4 FM, as there are few country-specific data, we use the default approach to calculate carbon stock changes in AR, called "Gain-loss approach", summarised by Equ. 3.2.22: ΔCLF(LB) = ΔCLF(G) - ΔCLF(L), where G = Growth and L = Loss. In terms of other losses, we concentrate on fires, one of the few biotic/abiotic damages which does not allow salvage logging.

➔ Estimating biomass growth in AR

As for 3.4 FM (see **Part 4.1 supra**), we follow the Gain-loss approach to estimate biomass growth using Equ. 3.2.23: ΔCLF(FG) = Σ (Ai x Gi) X CF, where

Ai = Area of AR type i (in ha). In our case, as presented earlier (see **Part 3.4 supra**), we distinguished four main AR types: high forest coniferous vs high forest deciduous, and intensive management (public and private plantations) vs extensive management (rehabilitation, erosion control, range rehabilitation, and energy forest);

CF = Carbon Fraction (tC/tdm), based on default value of 0.5 tC/tdm according to p3.25 of GPG LULUCF 2003;

Gi = Growth of AR type i (in tdm/ha/yr). Gi refers to the Equ. 3.2.5: Gi = Iv x D x BEF1 x (1 + R), where Iv = Volume Increment (m3/ha/yr), D = Basic Wood Density (tdm/m3), BEF1 = Biomass Expansion Factor (dimensionless), R = Root-to-Shoot ratio (dimensionless). All these variables were presented and calculated earlier (see **Part 3.4 supra**).

➔ Estimating biomass loss in AR

As for 3.4 FM (see **Part 4.1 supra**), we follow the Gain-loss approach to estimate biomass loss using Equ. 3.2.6: ΔCLF(L) = Lfelling + Lfuelwood + Lother loss. Felling is assumed to be restricted to the first thinning (conservatively assumed to include 20% of the AR and to be done after 15 years) and calculated with a slightly revised version of Equation 3.2.7. Firewood gathering is considered nil. Other losses are restricted to forest fires: the 1990-2020 area of forest fire is spread between Art. 3.4 FM and Art. 3.3 ARD, proportionally to the respective areas considered every year under 3.3 and 3.4.

➔ Estimating biomass loss in D

It is estimated using Equ. 3.2.9, as follows ΔCF-NF, LB = Aconversion x (Cafter-Cbefore + ΔCgrowth). Aconversion is estimated by triangulating ENVANIS (F) and OGM (AR) database and assumed to be equal to 1 376 ha/yr. Cbefore is estimated as the average carbon stock in forest, in absence of knowledge on localisation of D. Cafter is assumed to be 0, to be conservative, as recommended in p 3.124 of GPG LULUCF 2003. Cgrowth is assumed to be 0, in absence of geolocation of D.

➔ 1990-2020 net removals due to AR and D

Having done all our calculations, we can estimate net removals due to AR and D for the 1990-2020 time series. The results are as follow, expressed in MtCO2eq/yr of net removals (see detailed data in **Excel sheet 3.3**):

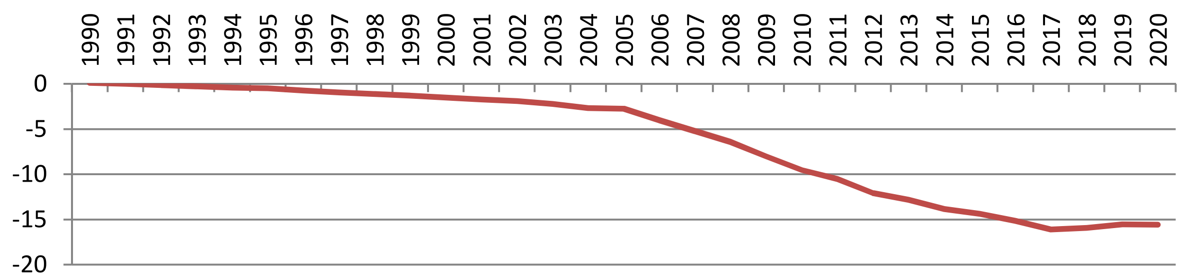

Figure 55 - 1990-2020 net removals due to AR and D (BOUYER, 2014)

Based on these results, and taking into account the upgraded LULUCF accounting rules for Art. 3.3 ARD (see **Part 2.3 supra**), 119.4 million of RMUs would be generated under this Article between 2013 and 2020 (see detailed data in **Excel sheet CCL 3.3**).

4.3. Operation and transaction and costs of pro-LULUCF policies & measures

➔ Policies and measures for promoting FM (Art. 3.4)

We can distinguish two categories of REL here ((see **Part 4.1 supra**):

- All RELs, excluding the projected REL: they would be capped at 3.5% of the 1990 total GHG emissions excluding LULUCF, therefore converting into a credit of 52.8 million of RMUs. The only operation costs is the forest management costs, estimated at 10 US$/ha/yr in the Report on Forestry Financing prepared for UNFF10 (OGM, 2013). Therefore, the overall operation cost would be 10 US$/ha x cumulative area under FM 3.4 from 2013 to 2020 = 771 MUS$ (see detailed data in **Excel sheet RECAP**). If we divide it by the 52.8 million of RMUs, we have an average forest management cost of 14.6 US$/RMU;
- Projected REL: in addition to the 14.6 US$/RMU, we have to estimate the opportunity cost associated with a deviation to the projected REL. To do so, we identify the levers for action (see detailed data in **Excel sheet CCL 3.4**): the emissions due to firewood collection and forest fire are marginal in the two scenarios (respectively 10% to 11%, and 1% of the forest growth), compared to emissions due to felling (61 to 54%):

	Int. Scen.		Ext. Scen.	
	MtCO2eq	% of growth	MtCO2eq	% of growth
F. Growth	-350,0		-350,0	
Felling	212,1	61%	190,6	54%
Firewood	37,3	11%	33,8	10%
Fires	3,2	1%	3,2	1%
Balance	-97,4		-122,4	

Figure 56 - % of growth lost by felling, firewood, fires under intensive vs extensive scenario (BOUYER, 2014)

Therefore, in the case of the projected REL, the main lever for action to go as close as possible to the 52. 8 MtCO2eq of the 3.4 FM cap, would be to reduce accordingly the level of felling. Using the Equ. 3.1.7. (estimation of carbon loss due to felling), we have (See **Excel sheets 3.4-Int or 3.4-Ext**):

Lfelling = (Hhf,con x Dcon X BEF2con + Hhf,con x Ddec X BEF2dec) X (1 - Fbl) X CF

We know the avoided Lfelling (difference between the cap and the RMUs achievable under the projected REL. See **Excel sheet CCL 3.4**), Dcon, Ddec, BEFcon and BEFdec (already calculated. See **Excel sheet KP Const**). We assumed Fbl is 0, we set CF = 0.5 tC/tdm, and we divide BEF2 by 0.85 to convert volume over bark into volume under bark (see in this **Part 4.1 supra**). The two unknowns are Hhf,con and Hhf,dec. We know from the Wood Marketing Database the current share of felling: 77% of coniferous and 23% of deciduous (see **Excel sheet RW OGM**).

With that, we can solve the equation as follows:

Lfell = Cap – RELproj = (Hhfcon x Dcon X BEF2con / 0.85 + Hhfdec x Ddec X BEF2dec / 0.85) X (1 - Fbl) X CF

(Cap – REL proj) / [(1 - Fbl) X CF] = Hhfcon x Dcon X BEF2con / 0.85 + 23/77 x Hhfcon x Ddec X BEF2dec /0.85

(Cap – REL proj) / [(1 - Fbl) X CF] = Hhfcon x (Dcon X BEF2con / 0.85 + 23/77 x Ddec X BEF2dec / 0.85)

Hhfcon = (Cap – REL proj) / [(1 - Fbl) X CF x (Dcon X BEF2con / 0.85 + 23/77 x Ddec X BEF2dec / 0.85)]

The calculation is presented in **Excel sheet CCL 3.4**. The results are summarised as follows:

Avoided felling to reach the cap under the RELproj	
Cap - credit if REL proj (tC)	-1 713 439
Hhfcon (m3)	-3 857 622
Hhfdec (m3)	-1 152 277
Hfcon (m3/yr)	-482 203
Hhfdec (m3/yr)	-144 035
Avoided tCO2eq per m3 of avoided felling	1,25

Figure 57 - Avoided felling to reach the cap under the RELproj (BOUYER, 2014)

Now, knowing the wood prices per types of products, we will further estimate the opportunity cost associated with the avoidance of one tCO2eq (= one RMU) in case of limited felling. We first estimate a weighted average price for coniferous and deciduous felling, knowing that their share in the total industrial roundwood production is respectively 77% and 23%, according to the 2013 data from the Wood Marketing Department:

	Total	3rd class log con	3rd class log dec	small logs	pulp wood	fiber chips
% of total roundwood	65%	18,5%	5,5%	4,4%	12,9%	23,8%
% of total ind. roundwood	100%	28,4%	8,5%	6,8%	19,8%	36,5%
Rel. breakdown con / product	77%	28,4%		5,2%	15,2%	28,1%
Rel. breakdown dec / product	23%		8,5%	1,6%	4,6%	8,4%
Abs. breakdown con / product	100%	37%	0%	7%	20%	36%
Abs. breakdown dec / product	100%	0%	37%	7%	20%	36%
	Price (TL/m3)	223	217	158	129	65
Weighted price of 1m3 con fell	**143**	83	-	11	26	24
Weighted price of 1m3 dec fell	**140**	-	80	11	26	24

Figure 58 - Weighted price of 1 m3 of coniferous vs deciduous felling (BOUYER, 2014)

Based on that, we estimate the opportunity cost of limiting the felling and, knowing the amount of avoided emissions, we estimate the opportunity cost associated with one RMU:

Avoided felling to reach the cap if Ext. Scen.		**Avoided felling to reach the cap if Int. Scen.**	
Cap - credit if Ext. Scen (tC)	1 713 439	Cap - credit if REL proj (tC)	14 389 523
Hhfcon (m3)	3 857 622	Hhfcon (m3)	32 396 453
Hhfdec (m3)	1 152 277	Hhfdec (m3)	9 676 863
Hfcon (m3/yr)	482 203	Hfcon (m3/yr)	4 049 557
Hhfdec (m3/yr)	144 035	Hhfdec (m3/yr)	1 209 608
Avoided tCO2eq per m3 of avoided felling	1,25	Avoided tCO2eq per m3 of avoided felling	1,25
Opportunity cost to reach the cap if Ext. Scen.		**Opportunity cost to reach the cap if Int. Scen.**	
Cost (TL) of avoiding Hhfcon	550 365 853	Cost (TL) of avoiding Hhfcon	4 621 993 174
Cost (TL) of avoiding Hhfdec	161 778 134	Cost (TL) of avoiding Hhfdec	1 358 618 869
Total cost (TL)	712 143 988	Total cost (TL)	5 980 612 043
Total cost (USD)	327 288 598	Total cost (USD)	2 748 581 979
Opportunity cost (TL/tCOeq)	113,4	Opportunity cost (TL/tCOeq)	113,4
Opportunity cost (USD/tCOe	52,1	Opportunity cost (USD/tCOeq)	52,1

Figure 59 - Opportunity cost in case of reduced felling to reach the cap under the RELproj (BOUYER, 2014)

Then, the total of operation cost, in the case of a projected REL, is 14.6 US$/RMU (operation cost for forest management) + 52.1 US$/RMU (opportunity cost of a reduced felling) = 66.7 US$/RMU. We can compare this estimate with different assumptions of carbon price:

- 4 US$/tCO2eq. This is the lowest values observed in 2013 on the European carbon market, the bigger Kyoto market worldwide;
- 7 US$/tCO2eq. In 2013, the average forest carbon price, on both Kyoto market (credits from AR CDM projects) and voluntary markets was 7 US$, according to the Ecosystem Marketplace report from 2013;
- 52 US$/tCO2eq. Commissioned by the French Prime Minister in 2008, a report estimated the “shadow price” of carbon, i.e. the recommended carbon price from 2011 up to 2050, to achieve the EU target of diving GHG emissions by four by 2050 (QUINET, 2009). The estimated value (by linear interpolation) for 2013 is 52 US$/tCO2eq.

None of these price estimates are above the operation costs associated with the creation of one RMU under the projected REL, which mean that carbon price itself does not suffice to redirect forest management decisions. However, adding other values on top of the carbon value does change this analysis (see **Part Recap infra**).

➔ Policies and measures for promoting AR (Art. 3.3)

We here focus on AR: D is at a quite marginal level and there is no clear lever for action, since D is not geolocalised and reasons why there is D are not clearly identified.

As explained previously (see **Part 3.1 supra**), and according to the internal document n°14.01.2014/4 from Permission and Easements Department of OGM, the average costs for public afforestation is 11 113.2 TL/ha for year 1 (establishment) and 1 020 TL/ha for the years 2 to 4 (maintenance). We also assume the same costs for private afforestation and, even if they are quite marginal, we take the private plantations into account in our following calculations: even if not supported by OGM, these costs are participating to the mitigation efforts of the country, and ultimately, will benefit to all.

According to information sent by the Sylviculture Department of OGM (February, 2014), the average costs for "natural regeneration" is 724 TL/ha for year 1 (intervention) and 122 TL/ha for the years 2 to 4 (maintenance). We use these last estimates for the following categories: rehabilitation, erosion control, range rehabilitation, and energy forest.

Here below are the results in terms of MUS$/yr (see detailed data in **Excel sheet CCL 3.3**):

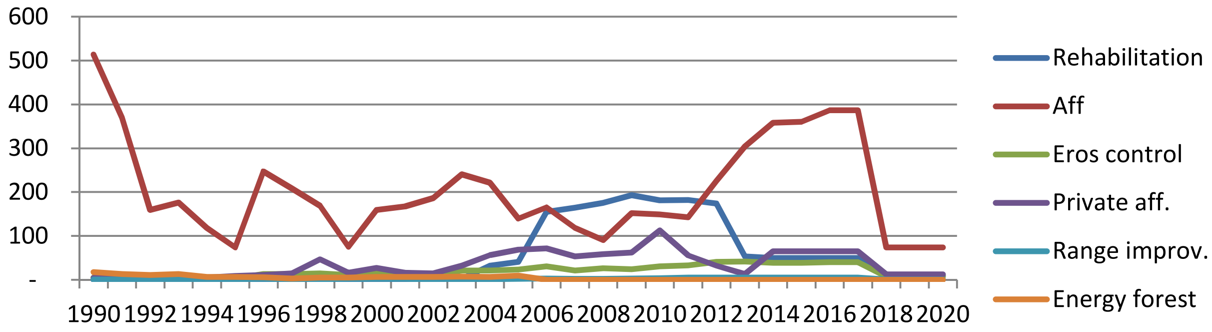

Figure 60 - Costs of plantations from 1990 to 2020, in MUS$/yr (BOUYER, 2014)

In addition to the costs of plantations (first four years), we also take into account the forest management costs (after the first four years), estimated at 10 US$/ha/yr in the Report on Forestry Financing prepared for UNFF10 (OGM, 2013). Here below are the results in terms of MUS$/yr (see detailed data in **Excel sheet CCL 3.3**):

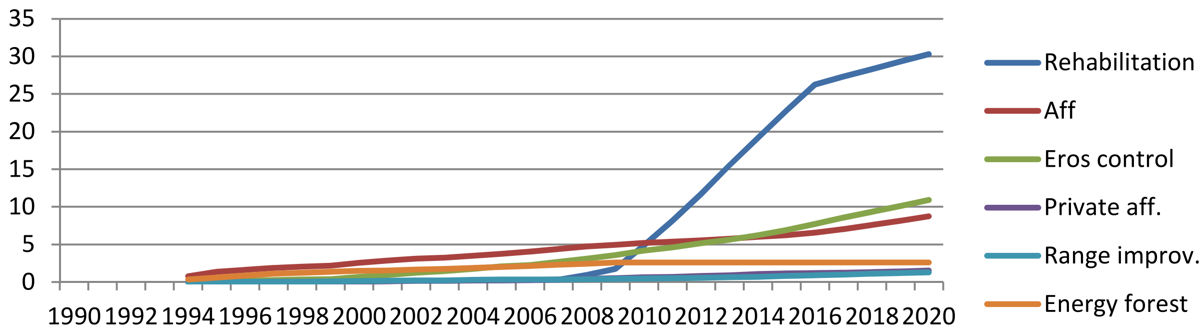

Figure 61 - Costs of maintenance of plantations from 1990 to 2020, in MUSD/yr (BOUYER, 2014)

From the above, it can be noticed that the costs of forest management of plantations are much reduced compared the costs of plantations themselves. Knowing 119.4 million of RMUs would be generated under Art. 3.3 ARD, the average operating cost would be 86.4 US$/RMU (see detailed data in **Excel sheet CCL 3.3**). As for 3.4 FM, it can be noticed that this operation cost is far above the current carbon price estimates, which means carbon alone may not be a "driver" for AR.

➔ Upgrading of the GHG inventory in the LULUCF sector

Costs factors for GHG inventory in the LULUCF sector may largely differ from one country to another, depending on the existence of "traditional" forest inventories (to estimate timber production), the level of national capacities, the availability of remote sensing data, the targeted degree of precision, etc.

To have an overview of costs involved, below is a summary of a Technical Paper from the UNFCCC Secretariat: "*Costs of implementing methodologies and monitoring systems relating to estimates of emissions from the forest sector*" (UNFCCC, 2009) (see detailed data in **Excel sheet MRV**).

This Technical Paper aimed at detailing MRV costs of REDD+, but it is useful basis for MRV costs of LULUCF, since the REDD+ activities are covered by the GPG-LULUCF 2003: (i) forest land converted to other land, which includes deforestation; (ii) forest land remaining forest land, which includes forest degradation, forest conservation, sustainable forest management and enhancement of carbon stocks; and (iii) other land converted to forest land, which includes enhancement of forest carbon stocks.

NB: unit cost: US$/ha, total cost: US$/forest area 2020	Minimum cost			Maximum cost		
	Unit	Total	Comment	Unit	Total	Comment
==> Cost factors for monitoring land use changes						
Data acquisition (archive for 3 historical dates)	-	-	Landsat (5TM / 7ETM+), 30 m resolution	0,007	1 611 330	SPOT-5 HRVIR, 10-20 m resolution
(GOFC-GOLF, 2008)						
Technical equipement and MRV office ressources		120 000			150 000	
(TP on costs of MRV, 2009)						
External expert support for capacity-building		120 000	10 000 US$/month during first year		360 000	30 000 US$/month during first year
(MOLLICONE et al., 2003, HARDCASTLE and BAIRD, 2008)						
Internal capacity-building		100 000	3 technical staff training at MSc level		140 000	idem
(HARDCASTLE and BAIRD, 2008)						
Human resources for data analysis (for 10 years)		850 000	Rec. costs = 25% of inital costs		2 166 667	Rec. costs = 33% of inital costs
(HARDCASTLE and BAIRD, 2008)						
	TOT.	**1 190 000**		**TOT.**	**4 427 997**	
==> Cost factors for monitoring forest C stocks						
IPCC tier 3 based on sampling strata, with degradation MR	0,002	54 818	5-year period for C stocks monitoring	0,067	1 648 267	5-year period for C stocks monitoring
(HARDCASTLE and BAIRD, 2008)						
	TOT	**54 818**		**TOT.**	**1 648 267**	
==> Cost factors for monitoring land use & forest C						
	G TOT.	**1 244 818**		**G TOT.**	**6 076 263**	

Figure 62 - Overview of costs involved in MRV of LULUCF (BOUYE, 2014, based on UNFCCC, 2009)

The cost factors for monitoring land use changes are mainly based on expert judgment (apart for the data acquisition of optical and/or radar images: observed costs). The cost factors for monitoring forest C stocks is based on country-specific cost estimates in 23 tropical countries (see detailed data in **<u>Excel sheet MRV</u>**).

In total, adapting these cost estimates to the total area of forest land foreseen by 2020 in Turkey, the range would be 1.2 to 6.1 MUS$ over a period of 10 years (thus covering the 2013-2020 KP2 period). But, taking into account the assessment of the current GHG LULUCF inventory (see **<u>Part 3.3 supra</u>**), the following facts can be used to refine this rough estimate:

- <u>In terms of monitoring of land use changes:</u> the ENVANIS database compile a lot of useful information (degree of degradation, main species, annual increment, firewood gathering and felling, etc.) disaggregated at the scale of the management unit and possibly geolocalised by the in-house GIS system of OGM (using infra-red images).

  Therefore, archive data (remote-sensing images and ENVANIS data) and human capacities are theoretically available for stratifying the forest area and geolocalising changes from one forest strata to another. Three major improvements may be done for the monitoring of forest area changes to be Kyoto compliant:

  - Adopting a country specific forest definition, including the definition of the minimal mapping unit of forest (to be comprised between 0.05 and 1 ha) for which land use changes will be tracked;
  - Reconciling the forest GIS and the CLC maps. Indeed, these two processes do not use the same land use classification and do not have the same resolution (3 ha for the current forest GIS, 25 ha for CLC). It may be possible to link the land use classifications used in both processes, in order to have a more coherent land use representation at national level, and specifically to track AR and D, which are not included in the forest GIS;
  - Organising the ENVANIS database (growth, specie composition, allowable cut for industrial roundwood and firewood, etc.), the Wood Marketing Division database (realised cut), the Forest Health Division database (biotic and abiotic damages, excluding forest fires), the Forest Fire Division database, as well as the Climate database and the Soil database (after reviewing its accuracy for the forest soils), in such a way that all these diverse data can be accessed through the forest GIS and allow tracking of forest area changes for the adopted minimal mapping unit.

    NB: the current resolution for the forest GIS (3 ha) and for the CLC maps (25 ha) are above the threshold for minimal mapping unit under the KP (0.05 to 1 ha). For CLC, it is not possible to have a better resolution. For forest GIS, it may be possible to track smaller polygons by using the existing infra-red images (question not asked to the GIS Division of OGM). In case it is not, for both CLC maps and forest GIS, a sample-size class distributions could be put in place, to estimate land use areas from low precision land use monitoring, as explained in 4.2.2.5.2 of the GPG-LULUCF 2003.

- In terms of monitoring of forest C stocks: the current ENVANIS database includes most of the necessary data for estimating carbon stock changes in living biomass. If the collected information could be geolocalised as suggested above, it would be good. In terms of DOM pools (litter and dead wood), further investigation would be needed to understand and document the DOM fluxes and allow estimating the related carbon stock changes.

  In terms of forest soils, at least the organic soils (less than 3% of the total area in Turkey) should be geolocalised and the related carbon stock changes should be reported. For the mineral soil, the conservative assumption that they are not source may be defensible, since D is marginal and AR are generally not carried out after ploughing and harrowing, but rather localised digging.

  More generally, after carrying out a key category analysis, the current emission factors in use could be reviewed for the key categories and country-specific values could be identified in the existing scientific literature, in order to increase the Tier level.

Coming back to the cost estimates, and taking into account that there is currently only one OGM expert for the preparation of the forest-related GHG inventory with only 10% of its time dedicated to this task (pers. com. Dr. Caglar BASSULLU - Foreign Relations, Training and Research Department of OGM, February, 2014), it can be assumed that most of the costs involved in the upgrading of the forest GHG inventory would be made of acquiring/redirecting additional human resources.

May be three experts at half time would suffice: (i) one GIS expert from the GIS Division of OGM, in charge of treating activity data, (ii) one ENVANIS expert from the Forest Management Division in charge of treating emissions factors, and (iii) one GHG expert on charge of preparing the GHG inventory.

Based on that, we can assume that the costs involved would be at the lower range of the estimates presented, i.e. 1.2 MUS$ for a period of 10 years (thus including the 2013-2020 period). As the estimated amount of RMUs under Art. 3.3 and 3.4 would range from 119.4 million of RMUs (0 for Art. 3.4 FM and 119.4 for Art. 3.3) to 172.2 million of RMUs (52.8 for Art. 3.4 FM and 119.4 for Art. 3.3), the transaction cost would range from 0.01 to 0.007 US$/RMU.

4.4. Non-carbon benefits

➔ Overview of past or partial sources of estimates

Different sources of estimates for non-carbon benefits of the Turkish forests have been made. They are either quite complete but not updated, or partial. In both cases, they are difficult to use: (i) the economics of Turkish forests changed a lot in the past decades and there is a need for updated data, (ii) the estimate of a particular value related to the forest (e.g. NWFP) is difficult to compare to other estimates (possible gaps and/or overlapping between different values).

We will therefore concentrate on the most recent and complete estimates of forest values, using the concept of "Total Economic Value" (see in the same **Part 4.4 infra**). But, in order to allow for crosschecking and triangulation of data, here below are quickly listed some past or partial sources of estimates, in chronological order:

- 1980. Estimate of contribution of the forests to the Gross National Product (GNP): 0.5 % in an appraisal study carried out by the State Statistical Institute (DİE) in 1980;
- 1998. Estimates of minimum values of Turkish forests in the Forestry Sector Review:

Benefit type	Benefit value (8)
1. Non-wood forest products	327 000 000
2. Wildlife	36 000 000
3. Recreation	2 000 000
4. Watershed conservation	131 000 000
5. non-recorded timber utilization	40 000 000
6. carbon deposit	463 000 000
7. genetic resources	89 000 000
8. Special values regarding protected areas (Research, training)	6 500 000
TOTAL	1 094 500 000

Table 11 - Estimates of different minimum values (in US$) of Turkish forests (Forestry Sector Review, 1998)

In the same document and based on a social evaluation in forest villages carried out in 1997: forest incomes account for 14% in average in the forest households' incomes, with 9% coming from timber use, 4% from forest employment income and 1% from grazing in forest land. The overall share varies from one region to another: 18% in the Black Sea Region, 15% in the Aegean Region, 11% in the Mediterranean Region. From 1985 to 2000; the number of forest villages has increased from around 17 000 to around 20 000, while the number of inhabitants has decreased from around 10 M to around 8 M, due to rural exodus.

- 2001. Estimates of minimum values of Turkish forests for the first National Forestry Congress:

Value Category		Benefit type	Benefit value	
			Dollar	%
Using Value	Direct using	Timber production	449 815 000	31.16
		Non-wood forest products	86 044 495	5.96
		Grazing, fodder utilization	225 000 000	15.59
		Hunting	17 219 854	1.19
		Recreation	2 071 880	0.14
	Indirect using value	Carbon deposit	801 000 000	55.48
	Alternative value	Medical utilization	112 500 000	7.79
Non-using Value	Life value	Conservation of biodiversity	1 380 000	0.10
	Heritage value			
TOTAL ECOMIC VALUE			1 692 959 349	100.00

Table 12 - Estimates of the economic values (in US$) of Turkish forests (TURKER et al., 2001)

- 2003. Various estimates in the National Forest Programme (NFP):
  - 100 MUS$/yr for the export value of NFWP, 4 700 t of game meat (i.e. equivalent to 2.5 million of domestic sheeps) if wildlife populations were brought to "normal" levels;
  - 190 trillion of TL for potential hunting revenue [NB: 127 billion of US$, using the exchange rate for 2003: 0.6694 US$/YTL, which appears enormous];
  - 48.1 billions of m3 of drinkable water produced from the forest (total consumption estimated at 104.5 billions of m3);
  - 0.8 Mha of forest range and grazing lands for forest villagers;
  - 85 000 man/yr of employment in the forest sector, with 47 700 man/yr for OGM and 35 000 man/yr for AGM. Payments done for timber harvesting operations (2002) cover some 20-25% of OGM budget and huge amount of the AGM budget consists of workers payment;
  - 1.76% of contribution of the forests to the GNP, taking into account important amount of hidden (illegal) production, as well as subsidies provided to forest villagers and to State institutions (i.e. pulp and paper industry, electrification agency, coal mining agency);
- 2005. Estimates of the values of different NWFPs in FAO FRA 2010 (based on 2005 data. TL was converted in US$ using the exchange rate for 2005: 0.7119 US$/TL). NB: These estimates appear very low compared to others:

Rank	Name	Key species	Data sources	Unit	Quantity (2005)	Value ('000 YTL)	Total value (USD)	Unit value (USD)
1	Pine nut	Pinus pinea L.	OGM, 2005	t	2 347	1 422 016	1 054 994	450
2	Trophies	Sus scrofa	OGM-MP, 2005	Number	843	517 441	383 889	455
3	Mushrooms	Boletus edulis	OGM, 2005	t	748	210 284	156 010	209
4	Bay leaves	Laurus nobilis L.	OGM, 2005	t	8 564	161 081	119 506	14
5	Thyme	Thymus serpyllum L.	OGM, 2005	t	974	65 622	48 685	50
6	Chestnut	Castanea sativa Mill.	OGM, 2005	t	130	12 969	9 622	74
7	Carob	Ceratonia siliqua L.	OGM, 2005	t	207	6 667	4 946	24
8	Moss	Homolothecium officinalis L.	OGM, 2005	t	104	5 210	3 865	37
9	Rosemary	Rosmarinus officinalis L.	OGM, 2005	t	46	3 309	2 455	53
10	Sumac leaves	Catanus coggyria Scop. Rhus coriariae L.	OGM, 2005	t	50	2 448	1 816	36
					TOTAL	2 407 047	1 785 788	

Table 13 - Estimates of the economic values (US$) of NWFPs of Turkish forests (FAO FRA, 2010)

- 2007. Estimate of the value added (gross figure, meaning including production and export taxes) from the forest sector: 81.4 trillions of TL, around 0.5% of the GNP, with 1/3 made of wages of forest workers (KAYACAN, 2007);
- 2008. Estimate of the total export value of NWFP in a FAO note: "*In terms of export earning, NWFPs are more valuable than primary products. They include resin, styrax, incense, bay leaves,*

red boxwood, gallnuts, carob, oregano, caper and liquorice […] exports of NWFPs was about 160 MUS$ in 2009, 221 MUS$ in 2010" (HAASE – FAO, 2011);

- 2010. Estimates of forest revenue (all Government revenue collected from the domestic production and trade of forest products and services), public expenditures (all Government expenditure on public institutions solely engaged in the forest sector), and transfer payments (all Government expenditure on direct financial incentives paid to non-government and private-sector institutions, enterprises communities or individuals operating in the forest sector) in the FAO FRA 2010 report:

	2000 TYL	2005 TYL	2 000 €	2 005 €				
Forest revenue	234 816 000	875 723 000	409 049 472	522 981 776				
Public expenditure	152 691 000	617 178 000	265 987 722	368 578 702		2000	1,742	€/TYL
Net revenue (total)	82 125 000	258 545 000	143 061 750	154 403 074		2005	0,5972	€/TYL
Forest area (FL+NWL)	20 846 749	21 237 305	20 846 749	21 237 305				
Net revenue (/ha)	3,9	12,2	6,9	7,3				

Table 14 - Forest revenue and expenditure (in TL and €) in 2000 and 2005 (FAO FRA, 2010)

- 2012. Estimate of contribution of the forests to the GNP: 0.8 %, according to the 2013-2017 OGM Strategic Plan.

In conclusion: all these estimates are useful to triangulate data, but do not allow estimating all the diverse values of Turkish forest. Therefore, we now focus on the estimation of the Total Economic Value (TEV) of forests.

➔ Most recent and complete estimates of the TEV of the Turkish forest

This section will mainly rely on the following article "*Total economic value of forest resources in Turkey*" (PAK et al., 2010), with crosschecking of data contained in the following articles and reports: "*The impact of forest fire damages on the total economic value of forest resources in Turkey*" (TURKER et al., 2005), "*Economic valuation of externalities linked to Turkish forests*" (OZTURK et al., 2009), "*Report on forestry financing, prepared for UNFF10*" (OK et al. 2013).

The components of the total economic value can be represented as follows:

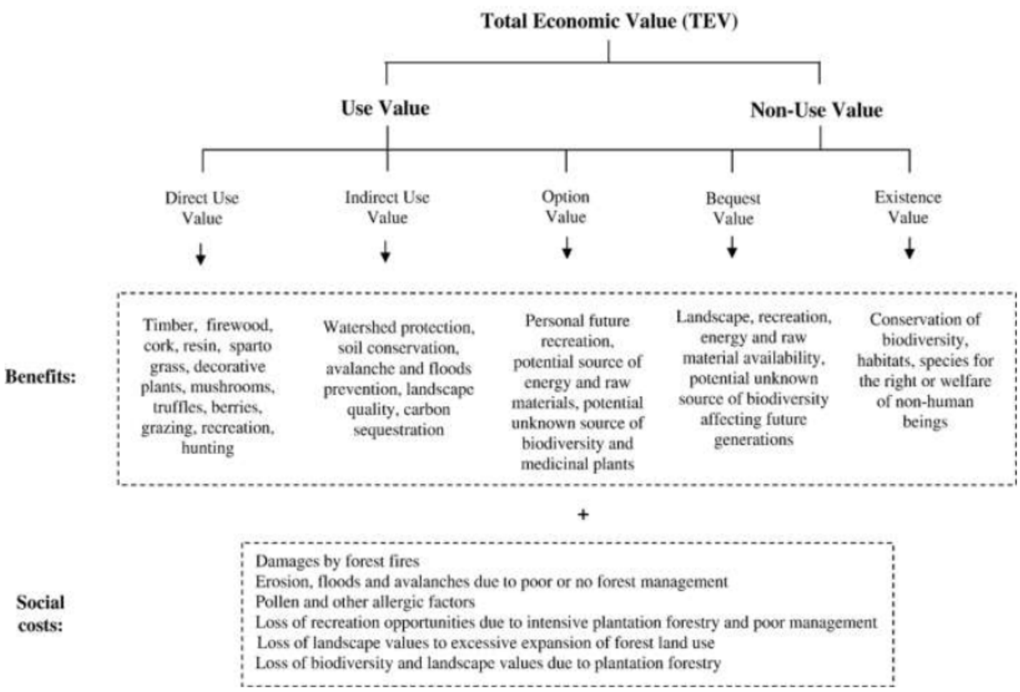

Figure 63 - Components of the Total Economic Value (TEV) of forest (CROITORU, 2007)

The definitions of the main components are as follow (all these definitions are extracted from PAK et al., 2010, with further precisions if underlying quotations):

- Use value: benefit obtained by individual by directly using the natural resource, e. g. values associated with outdoors recreation (ADAMOWICZ, 1995). Use values are divided into:

  - o Direct use value: it includes consumptive uses, e.g. felling, hunting, etc. and non-consumptive uses, e.g. hiking, camping, boating, etc. (FAUSOLD and LILIEHOLM, 1996);
  - o Indirect use value: it can be illustrated by the reading of books related to the natural resource or the watching of television programmes about wildlife (FAUSOLD and LILIEHOLM, 1996);
  - o Option value: value of a resource that will be possibly spoiled in the future (KULA, 1994);
- Non-use value: value estimated for the natural resources although they are not used in fact. Non-use values are divided into:
  - o Existence value: it is placed on a amenity, even though individuals may never use or visit it; however, it is important for them to know that it will continue to exist (CONDON and ADAMOWICZ, 1998; KLEMPERER, 1996);
  - o Bequest value: willingness to pay to preserve some resource for future generation (KLEMPERER, 1996).

These different values have been estimated in Turkey, using valuation techniques presented below:

Externality-Value type		**Outputs**	**Valuation techniques**	**Physical indicators**	**Monetary indicators used (€)**
Positive externality	Direct use value	Grazing	Substitute goods	Quantity of forage grazed (FU)	Price of hay
	Indirect use value	Carbon sequestration	Shadow price	Net change of carbon sequestrated in forest biomass (tC)	Shadow price of carbon
	Option value	Pharmaceuticals	Rent capture	Plant species (no.)	Market price of pharmaceuticals
	Bequest-Existence value	Biodiversity conservation	Cost-based approach	Protected area (ha)	Annual expenses for preserving biodiversity
Negative externality		Erosion, floods and landslides	Change in production function (quantitative valuation) and replacement cost (monetary valuation)	Loss of soil nutrients (t)	Cost of fertilizers
		Damage caused by forest fires	Restoration cost/or value of damage	Area burnt by fires (ha)	Cost of restoration/or value of wood

Figure 64 - Valuation techniques to estimate the TEV of forests (MERLO and CROITORU, 2005)

Applying these valuation techniques, here below are the final results:

TEV components	**Type of outputs**	**Value (US $) per year**	**(%)**	
Direct use values	Wood based forest products	1165178097.46	68.35	84.03
	Non-wood forest products	454292.02	0.03	
	Grazing	225000000.00	13.20	
	Hunting	35948500.00	2.11	
	Recreation	5950000.00	0.35	
Indirect use values	Carbon storage	158400000.00	9.29	
Option value	Pharmaceuticals	112500000.00	6.60	
Non use values	Existence value (to conserve biodiversity)	1380000.00	0.08	
Positive TEV components		1704810889.48	100.00	
Negative externalities	Erosion	-125 000 000.00	93.56	
	Risk of damage by forest fires	-8 607 537.00	6.44	
Negative TEV components		-133 607 537.00	100.00	
Net total economic value of Turkish forests		1 620 459 352.58		

Figure 65 - Disaggregation of the TEV of the Turkish forests (PAK et al., 2010)

Comparing these values with the estimates presented earlier (see first section of the same **Part 4.4 supra**) is quite difficult, since these former estimates were either classified by economic agents (e.g. % of GNP for the State, wages for the forest workers, revenue and forest livelihood for the forest villagers) or not based on the same perimeter (e.g. most of the estimates for NWFPs are only considering the OGM revenue, and not the overall revenue for OGM + middlemen + forest villagers). It highlights the crucial need to try, as much as possible, to use common terminologies and assumptions when valuing forest amenities.

This being said, if we compare the data from PAK et al., 2010, with other set of data, we can underline the following:

- Wood based products: this estimate (roughly 1.17 trillion of US$/yr) is considerably higher than the one - 0.45 trillion of US$/yr - from BANN and CLEMENS, 2001, quoted in TURKER et al., 2002 and TURKER et al., 2005, as well as the one – 0.86 trillion of U$/yr – from OK et al., 2013. Indeed, this estimate is more recent (more felling than in 2001, explaining the difference with BANN and CLEMENS, 2001), and consider a larger perimeter than the sole OGM wood based products (existence of private felling, explaining the difference with OK et al., 2013). It appears reasonable to use this estimate;
- NWFPs: This estimate (roughly 0.45 MUS$/yr) appears extremely low, compared to the one - 86 MUS$/yr - from BANN and CLEMENS, 2001, quoted in TURKER et al., 2002 and TURKER et al., 2005. It is roughly three times less than the one – 1.35 MU$/yr – from OK et al., 2013, but this one itself may be an underestimate, since it considers only OGM revenue.

  For these reasons, it appears preferable to use the latest estimates produced by the NWFPs Division of OGM: roughly 335 MTL in 2012 and 514 MTL in 2013, taking into account OGM revenue + middlemen revenue + forest villagers' revenue. Averaged and converted in US$, it gives 195 MUS$/yr;
- Hunting: this estimate – roughly 35.9 MUS$/yr – sums the hunting and fishing values. The estimates in BANN and CLEMENS, 2001, quoted in TURKER et al., 2002 and TURKER et al., 2005, are of the same order of magnitude: 17.8 MUS$/yr for hunting and 20.1 MUS$/yr for fishing, i.e. 37.9 MUS$/yr in total. Since the estimate from PAK et al., 2010, is of the same order of magnitude and more recent, it is proposed to retain it;
- Recreation: the estimate – roughly 5.9 MUS$/yr – is three times less than the sole official revenue from National Parks (33.4 MTL in 2012, i.e. 15.4 MUS$/yr), according to OK et al., 2013. Since this last estimate is conservative (it does not include the recreational value of forests outside National Parks) and official, it is proposed to use this last one;
- Carbon storage: this value has been reviewed according to the IPCC inventory guidelines and Kyoto accounting rules (see **Parts 4.1 and 4.2 supra**);
- Other values and costs: grazing value and pharmaceutical value, as well as the erosion cost and forest fires costs are the same in PAK et al., 2010, and BANN and CLEMENS, 2001, quoted in TURKER et al., 2002 and TURKER et al., 2005. Having no better data, we use these estimates.

Here below is presented a revised disaggregation of the TEV of Turkish forest, according to the above (see detailed data in **Excel sheet TEV**):

TEV components	Type of outputs	Value (US$/yr)	Source	%
Direct use values	Wood based forest products	1 165 178 097	PAK and al., 2010	66,6%
	NWFPs	195 359 161	OGM, 2014	11,2%
	Grazing	225 000 000	PAK and al., 2010	12,9%
	Hunting	35 948 500	PAK and al., 2010	2,1%
	Recreation	15 373 881	OGM, 2013	0,9%
Indirect use value	Carbon storage (treated in **Parts 4.1 and 4.2 supra**)			
Option value	Pharmaceuticals	112 500 000	PAK and al., 2010	6,4%
Non-use Value	Existence value (biodiversity)	1 380 000	PAK and al., 2010	0,1%
	Positive TEV components	**1 750 739 640**		
Negative externalities	Erosion	-125 000 000	PAK and al. 2010	94%
	Forest fires	-8 607 537	PAK and al. 2010	6%
	Negative TEV components	**-133 607 537**		
Net total TEV of forests (excl. C storage) in US$/yr		**1 617 132 103**		
Average area of productive forests in 2010-2013 in ha		**11 374 414**		
Net total TEV of forests (excl. C storage) in US$/yr/ha		**142**		

Table 15 - Revised disaggregation of the TEV of Turkish forest (BOUYER, 2014, based on PAK et al., 2010)

4.5. Summary: Recap of costs & benefits and key findings

NB: Cost-benefit estimates are expressed in monetary terms, i.e. USD, not implying that the international community should necessarily reward Turkey, but rather because it is the easiest way for valuing very diverse direct and indirect, tradable and non-tradable, costs and benefits.

The carbon credits, or Removal Units (RMUs), for Art. 3.3 ARD and Art. 3.4 FM (including the carbon storage in harvested wood products) were estimated using the guidelines from the Intergovernmental Panel of experts on Climate Change, and taking into account the upgraded LULUCF rules.

For Art. 3.4 FM, it depends on different manners to set the Reference Emissions Levels (RELs):

All numbers in MtCO2eq	**Number of**	**Corresponding**	**Difference if**		**Removal Units**	
Choice of REL	**Annex 1 Parties**	**REL in Turkey**	**Int. Scen.**	**Ext. Scen.**	**Int. Scen.**	**Ext. Scen.**
2020 projections	31 (incl. 24 EU States)	-235,7	0,0	-46,5	-	46,5
Historical 1990	3 (Belarus, Norway, Russia)	-157,0	-78,7	-125,2	52,8	52,8
Average 1990-2009	1 Greece	-176,2	-59,5	-106,0	52,8	52,8
Linear trend 1900-2008	2 (Cyprus and Malta)	na (no linear trend)			-	-
0	1 (Japan)	0	-235,7	-282,2	52,8	52,8
1990 GHG emissions in Turkey excl. LULUCF (tCO2eq/yr)		188,4		Cap of 3.5%	-52,8	

Figure 66 - Five different RELs for Art. 3.4 FM in Turkey and numerical consequences (BOUYER, 2014)

For Art. 3.3, it was estimated that 119.4 million of RMUs could be generated between 2013 and 2020, which is more than two times the maximum amount of RMUs to be generated under Art. 3.4 FM.

The operation and transaction costs associated with Art. 3.3 and Art. 3.4 were then estimated:

- For Art. 3.4, the operation cost is equal to the cost of forest management, which converts into 14.6 US$/RMU. If the REL is projected, then an additional 52.1 US$/RMU of opportunity cost for reduced felling has to be added, thus amounting to 66.7 US$/RMU;
- For Art. 3.3, the operation cost is made of plantation cost (for year 1 to 4) and forest management cost (from year 5 onward) and amounts up to 86.4 US$/RMU.
- For Art. 3.3 and Art. 3.4, the transaction cost is mainly made of upgrading of the current LULUCF inventory. It is assumed to be marginal, around 1.2 MUS$ in total as most of the data sources are already available and the main efforts to be done would be in terms of human resources. The transaction cost would therefore range from 0.01 to 0.007 US$/RMU.

Last but not the least, the different non-carbon values (wood and non-wood products, grazing, hunting, recreation, pharmaceuticals use) and costs (erosion, forest fires) forming the Total Economic Value (TEV) of the Turkish forest were reviewed: the revised TEV is estimated at 142 US$/ha/yr.

Based on the above, a complete assessment of carbon and non-carbon costs and benefits of implementing the LULUCF rules was carried out, for four different 3.4 FM scenarios (extensive vs intensive harvest, projected vs non-projected REL) and one single 3.3 AR scenario:

Scenario for 3.4 FM, depending on the level of harvest by 2020 (in Mm3/yr)	REL non projected*		REL projected	
	Ext. harvest	Int. harvest	Ext. harvest	Int. harvest
	32,3	36,3	32,3	36,3
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int
Scenario for 3.3. ARD: 2013-2017 OGM Strategic Plan, followed by linear trend from 2018 to 2020				
Cumulative area under 3.4 FM (ha, over 2013-2020)	77 145 301			
Non-C benefit for 3.4 FM (MUS$)	**10 968**			
Cumulative gain of forest under 3.3 ARD (ha, over 2013-2020)	19 046 995			
Non C-benefit of 3.3 AR (MUS$)	**2 708**			
3.4 FM RMUs between 2013-2020 (Million of RMUs)	52,8	52,8	46,5	0
C benefit for 3.4 FM (MUS$)	**264**	**264**	**232**	**0**
3.3 ARD RMUs between 2013-2020 (Million of RMUs)	119,4			
C benefit for 3.3 ARD (MUS$)	**597**			
Operation costs for 3.4 FM: forest management (MUS$)	**771**			
Operation costs for 3.3 ARD: AR and forest management (MUS$)	**3 221**			
Transaction costs for GHG LULUCF inventory (MUS$)	**1**			
TOTAL	**7 835**	**7 835**	**7 804**	**7 571**
** historical level 1990, or average 1990-2010 or 0 (see detailed data in **Excel sheet CCL 3.4**)*				

Figure 67 - Recap of costs and benefits estimates of LULUCF accounting for different scenario (BOUYER, 2014)

All the costs are assumed to be constant, whatever the scenario. The sensibility of the estimated benefits to different carbon price assumption was carried out:

- 4 US$/tCO2eq. This is the lowest values observed in 2013 on the European carbon market, the bigger Kyoto market worldwide;
- 7 US$/tCO2eq. In 2013, the average forest carbon price, on both Kyoto market and voluntary markets was 7 US$, according to the Ecosystem Marketplace report from 2013;
- 52 US$/tCO2eq. Commissioned by the French Prime Minister in 2008, a report estimated the "shadow price" of carbon, i.e. the recommended carbon price from 2011 up to 2050, to achieve the EU target of diving GHG emissions by four by 2050 (QUINET, 2009). The estimated value (by linear interpolation) for 2013 is 52 US$/tCO2eq

if RMU price (US$)	***4***	**2013 EU C market price**				
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int		
Non-C benefit 3.4	98%	98%	98%	100%	Non-C benefit 3.3	85%
C benefit 3.4	**2%**	**2%**	**2%**	**0%**	C benefit 3.3	**15%**
Total benefit 3.4	100%	100%	100%	100%	Total benefit 3.3	100%
if RMU price (US$)	***7***	**2013 forest C price**				
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int		
Non-C benefit 3.4	97%	97%	97%	100%	Non-C benefit 3.3	76%
C benefit 3.4	**3%**	**3%**	**3%**	**0%**	C benefit 3.3	**24%**
Total benefit 3.4	100%	100%	100%	100%	Total benefit 3.3	100%
if RMU price (US$)	***52***	**2013 C shadow price**				
	Sc NP-Ex	Sc NP-Int	Sc P-Ex	Sc P-Int		
Non-C benefit 3.4	80%	80%	82%	100%	Non-C benefit 3.3	30%
C benefit 3.4	**20%**	**20%**	**18%**	**0%**	C benefit 3.3	**70%**
Total benefit 3.4	100%	100%	100%	100%	Total benefit 3.3	100%

Table 16 - Sensibility analysis of C vs non-C benefits with regard to C price (BOUYER, 2014)

As it can be observed, taking into account the recent EU Market price (Kyoto market) or the recent forest carbon price (Kyoto and voluntary markets), the carbon benefits are reduced in all the scenarios, compared to other values included in the TEV of forest.

However, since most of the operating costs would have been disbursed anyway (apart for the transaction cost for upgrading the GHG LULUCF inventory, but it is marginal: 1.2 MUS$), the carbon benefits can be assumed to be "extra net-benefits". Furthermore, at the contrary to many forest values, the carbon benefits can materialise.

Last but not the least, if we consider the carbon shadow price, it is worth noting that the situation is quite different: for the 3.4 FM areas, and mainly for 3.3 ARD areas, the carbon benefits are substantial. However, this price level is still far from reach as the negotiations stand now…unless the international community is able to adopt a strong political commitment in the coming years.

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