

Chapter 8

Cost-Benefit Assessment of Implementing LULUCF Accounting Rules in Turkey

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Abstract Turkey is an Annex 1 Party with “Specific circumstances” because it has the fastest population growth rate among the Organization for Economic Cooperation and Development (OECD) countries and lowest per capita energy-related CO₂ emissions among the International Energy Agency (IEA) countries. In addition, all national indicators show that Turkey is in fact a developing country. It was deleted from Annex 2 of the United Nations Framework Convention on Climate Change (UNFCCC) and not included in the Annex B of the first term of the Kyoto Protocol (KP1). In the context of preparation of a 2015 multilateral treaty on climate change, which would enter into force in 2020, differentiation between Annex 1 and non-Annex 1 Parties may be revisited, and it seems useful to explore the possible consequences of such a reclassification. Accordingly, this study aims at providing a neutral cost/benefit assessment of implementing Land Use, Land Use Change and Forestry (LULUCF) accounting rules in Turkey in the future, as one possible scenario. 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 or any possible COP decision that may determine its future classification, considering its specific circumstances. Turkey started reporting LULUCF under the Climate Convention in 2006. Presently, the LULUCF sink (made of a forest sink for its bigger part) is estimated to offset 12 % of Turkey’s total greenhouse emissions. For afforestation/reforestation (A/R) (Article 3.3), the objectives of the 2014–2017 OGM (General Directorate of Forestry Turkish abbreviation) Strategic Plan were considered. For forest management (FM) (Article 3.4), two alternative scenarios were considered: 90 Mm³ of roundwood harvest between 2013 and 2017 (intensive harvest) and 25 Mm³/year of felling (industrial round wood) harvest by 2020 (extensive harvest). The corresponding volumes of firewood, felling and total round wood were forecast accordingly from 2013 to 2020. The carbon credits or Removal Units (RMUs) for

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Article 3.3 ARD and Article 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 Article 3.3, it was estimated that 119.4 million RMUs could be generated between 2013 and 2020, which is more than twice the maximum amount of RMUs to be generated under Article 3.4 FM. The total economic values (TEVs) of Turkey's forests have been estimated based on recent studies and then used to calculate benefits. Taking into account the recent European Union (EU) market price (Kyoto market) or the recent forest carbon price (Kyoto and voluntary markets), carbon benefits are reduced in all scenarios compared with other values included in the TEV of the forest. If we consider the carbon shadow price (i.e. the recommended carbon price from 2011 to 2050, to achieve the EU target of reducing GHG emissions fourfold by 2050), 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 attainable as negotiations stand now, unless the international community is able to adopt a strong political commitment in coming years.

Keywords Climate change · Mitigation · Cost-benefit analysis · Kyoto Protocol · LULUCF

8.1 Introduction

Many developed countries involved in the UNFCCC have lost their motivation in the last 4–5 years, and this is reflected in the Kyoto Protocol's second term. The number of parties that have commitments in the second Kyoto term (2013–2020) is less than the number in the first round (2008–2012). However, some achievements have been realized due to the efforts of dedicated parties and institutions, such as the creation of a register of nationally appropriate mitigation actions (NAMAs), a green climate fund, an adaptation committee and a climate technology center, and refining the REDD+ mechanism (reducing GHG emissions from deforestation and forest degradation and maintaining or increasing forest carbon stocks).

The last COP was held in Warsaw in December 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 towards achieving a ‘loss and damage’ mechanism.

Negotiations advanced efficiently on finance and emission reduction targets for the last 2 years on the way to Paris. A new agreement has been prepared but it is unlikely that the new established working group to reveal the mechanisms of the agreement will progress efficiently in the coming years if the ‘chicken and egg’ blockage continues:

- As part of the post-2020 multilateral treaty, most developed countries support a review of the dichotomy between Annex 1 and Non-Annex 1 Parties; this differentiation dates 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 have called on developed countries to drastically raise their level of ambition: (i) few of them have commitments (only 15 % of global GHG emissions are covered), (ii) commitments are well below IPCC (2013a) recommendations to stay the global temperature increase less than +2 °C.

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

8.2 Position of Turkey in the UNFCCC

Figure 8.1 seeks to summarize Turkey’s current situation with regard to the Organization for Economic Cooperation and Development (OECD) and the Annexes (1 and 2) of the UNFCCC: Five countries are particularly singled out:

- USA(*): They signed the KP but did not ratify it and have no commitments under 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 (***) : As they were considered to be developing countries at the time of Kyoto, they were not included in Annex B;
- Belarus (****): Also part of Annex 1 but not included in Annex B to the KP (Decision 10/CMP.2 amending the Annex B with Belarus was never approved by other Parties).

Since 1992, Turkey has been advocating for recognition of its special circumstances. Thus, 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 states that three delegations (Bulgaria, Czechoslovakia and Turkey)

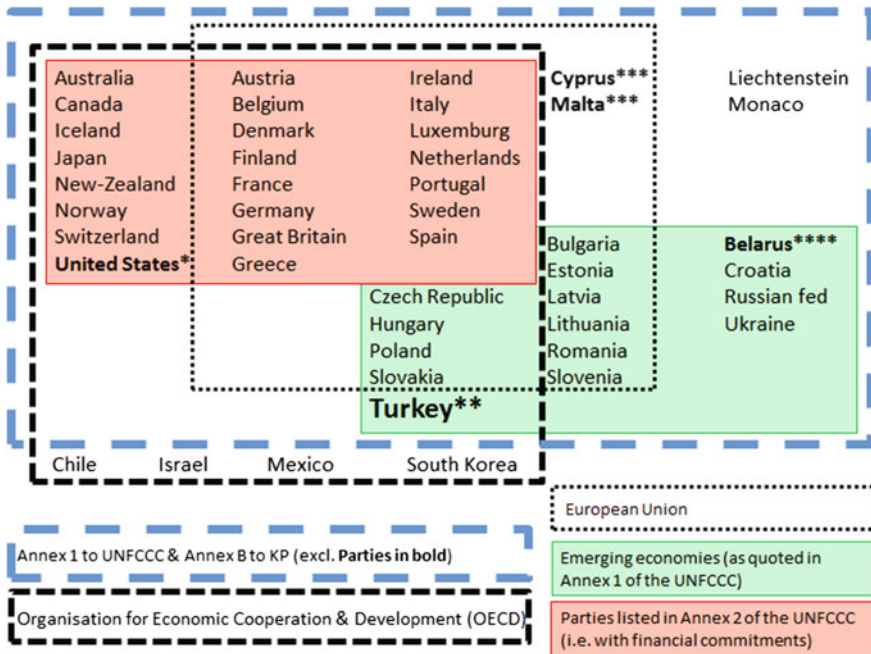


Fig. 8.1 Turkey in the OECD and Annexes 1 and 2 of the UNFCCC. Source Bouyer (2014)

reserved their positions regarding the listing of countries in the Annexes to the Convention (UN General Assembly 1992). In 1997, Turkey revealed its positions in detail through a submission sent to the Secretary of the UNFCCC (UNFCCC 1997a, b): (i) Turkey wants to be considered a developing country and (ii) Turkey requests its deletion from the Annexes 1 and 2 of the UNFCCC. To substantiate these requests, the following key facts were presented:

- “Turkey, with approximately 64 million inhabitants as of 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; the 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 Nations Development Program (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’s stance 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, prior 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 and (iii) Turkey needs support for finance, technology and capacity building for mitigation and adaptation.

In 2010, at COP16, 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 recognize the special circumstances of Turkey that place it in a situation different from those of other Annex 1 Parties and eligibility for support under Article 4, paragraph 5, of the UNFCCC. Turkey 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, Article 170 of Decision 1/CP.17 recalled the key elements of the Decision 26/CP.7 and Decision 1/CP.16 (UNFCCC 2012a, b). Since COP18 in Doha and COP19 in Warsaw, the situation has remained the same: (i) Turkey is an Annex 1 Party, having specific circumstances setting it apart from the other Annex 1 Parties; (ii) Turkey is not part of Annex 2 of the UNFCCC, and thus it is not expected to contribute to the climate financing regime but rather to benefit from it and (iii) Turkey does not have a 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 versus Non-Annex 1, as well as the implementation of the UNFCCC principles (historical responsibility, CBDR, equity, etc.) are of interest to Turkey.

8.3 Forest Sector in the UNFCCC

8.3.1 Key Features of LULUCF and REDD+

‘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 N₂O (emitted to the atmosphere by biomass burning or anaerobic and aerobic fermentation, respectively), are considered through two mechanisms, LULUCF and REDD+, the key features of which are shown in Table 8.1.

8.3.2 Which Mechanism for Turkey?

It is worth noting that the concept of 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.

There are different interpretations of Article 142 of Decision 1/CP.16 and Article 170 of Decision 1/CP.17 regarding Turkey’s ‘specific circumstances’ and its eligibility for NAMAs: ‘Turkey is fully eligible for support in development of NAMAs’ (UNDP 2011) compared to the statement ‘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).

In any case, considering, on one hand, the current rules governing the LULUCF and REDD+ (and NAMAs) mechanisms and, on the other hand, Turkey’s current classification by the UNFCCC as a developed country and thus its inclusion in Annex 1 of the UNFCCC, the only mechanism that may theoretically apply to Turkey is the LULUCF mechanism, which is consistent with the following processes:

- Preparation of a post-2020 multilateral climate treaty: In this context, it is conceivable to have a ‘reclassification’ in terms of Annex 1 versus Non-Annex 1 and increased pressure placed on Annex 1 Parties to undertake binding commitments;
- Alignment with the European Union (EU) Acquis: Since the European Council of Helsinki in 1999, Turkey has been a candidate member of the EU. Accession negotiations started at the European Council of Copenhagen in 2002, and the national program for adoption of the European Acquis started in 2003. As part of this program, 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 the fact that ‘no progress’ had been made in that field (European Commission 2013).

Table 8.1 REDD+ versus LULUCF: key features

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	
<ul style="list-style-type: none"> • 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 versus Non-Annex 1 is being discussed, considering UNFCCC principles: CBDR, Historical responsibility, Equity, etc. 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 Annex 1 could be included in Annex 1	
Objective	
<p>Reward net removals from forest/agric. sinks:</p> <ul style="list-style-type: none"> • Under Article 3.3 of the KP: net removals from afforestation/reforestation (A/R) done after 1990. This accounting is compulsory • Under Article 3.4 of the KP: net removals from managed forests in existence before 1990 (Forest Management; FM) as well as their derived harvested wood products (HWP). Accounting is compulsory • Under Article 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 	<p>Reward increased net removals or avoided emissions from the following activities:</p> <ul style="list-style-type: none"> • Avoiding emissions from Deforestation (1st D); • Avoiding emissions from Degradation (2nd D); • Increasing net removals from A/R (in the ‘+’) • Increasing net removals from FM (in the ‘+’) <p>REDD+ is a voluntary mechanism</p>
Political requirement	
<ul style="list-style-type: none"> • 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.

(continued)

Table 8.1 (continued)

LULUCF	REDD+
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'	
<ul style="list-style-type: none"> • Costs of getting prepared for either LULUCF or REDD+ (e.g. reference level for Article 3.4 FM, RPP, etc.) • Costs of implementation of 'pro-climate' forestry and agriculture activities • Costs of running the MRV system 	
'Main benefits'	
<ul style="list-style-type: none"> • 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 Article 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 	<ul style="list-style-type: none"> • 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

Source Bouyer (2014)

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”.

8.3.3 Mitigation Options in the Forest Sector

Many mitigation options exist in the forest sector:

- Avoiding deforestation and forest degradation: This is clearly the most obvious option. It is considered frequently for tropical developing countries (who often face 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 forests stands’ resilience 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 FM (SFM): Carbon removal in existing forests can be improved by measures such as 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 substantial);
- Afforestation/reforestation (A/R): This category covers different modalities of converting 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 (and only if) the forest is sustainably managed. One ton of oil equivalent (toe) can be substituted by four cubic meters of fresh wood and, consequently, avoid the emission of three tCO₂eq;
- Carbon storage in harvested wood products (HWP): Carbon can be stored in long-life wood products (wood frames, wardrobes, 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 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 that of ‘fossil’ materials (iron, concrete, glass, etc.). In France, 1 m³ of wood used as building or housing material avoids 0.8 tCO₂eq in average (*Institut technologique Forêt-Cellulose-Bois-construction-Ameublement*, FCBA 2011).

8.3.4 Translation into the UNFCCC and the KP: LULUCF

The need to preserve ‘reservoirs’ (a component or components of the climate system where a GHG [...] is stored) and ‘sinks’ (any process, activity or mechanism which removes a GHG [...] from the atmosphere) was first mentioned in the following articles of the UNFCCC (UNFCCC 1992):

- Article 4.1 (d) states 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”;
- Article 4.2 (a) states 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”;

- Article 12.1 (a) states 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 LULUCF was created through two articles of the KP (1997a, b):

- Article 3.3 states 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”;
- Article 3.4 states 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, four years of intense negotiations on the LULUCF occurred for determining 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 provided a good outline of the LULUCF modalities, rules and guidelines (in Part VII) and introduced for the first time an ‘Appendix Z’ that listed the levels of the ‘cap’ to be applied to ‘Forest Management’ (FM) activities under Article 3.4 of the KP (see explanations *infra*).

Finally, Decision 11/CP.7 was adopted in Marrakech; it compiled all the elements of the above-mentioned LULUCF Decisions (9/CP.4, 16/CP.5 and 5/CP.6) and presented, in an annex, a draft CMP Decision containing 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 Articles 3.3 and 3.4 of the KP, could only be adopted by the CMP, which was created in 2005, after the KP’s entry into force.

In parallel, the IPCC, following a political request from the COP and CMP and under the technical guidance of the SBSTA, developed technical guidelines and methodologies for reporting and accounting 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).

8.4 Materials and Methods

An ad hoc database on forest carbon stocks, as well as carbon and non-carbon fluxes, has been created to make the estimations in this study. We used the most recent data (Management Plans, ENVANIS—The Turkish FM Inventory System, National Inventory Report for GHG, etc.) as well as future projections, in particular the 2014–2017 Strategic Plan of General Directorate of Forestry (OGM 2012) and a wide range of data/information communicated by various experts from the Ministry of Forest and Water Affairs.

8.4.1 *Upgraded LULUCF Rules*

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 agricultural soils are considered under the ‘LULUCF’ as part of the greenhouse inventory, while CH₄ and N₂O emissions are considered under the ‘Agriculture’ part). This sector offers great mitigation potential: avoided deforestation and degradation, sustainable FM, A/R, substitution of fossil fuel, carbon storage in wood products and substitution of ‘grey energy’ in building and housing materials.

However, this mitigation potential has been poorly realized until 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 and non-additionality of a certain part of the carbon sequestration.

Some political concerns also existed when the Kyoto Protocol was being designed: lack of scientific knowledge and consensus on forest sinks, fear of

dilution of efforts, agenda inversion 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 established in 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, which runs from 2013 to 2020.

The main features of these upgraded rules are as follows: (i) accounting for A/R and deforestation under Article 3.3 is still mandatory (and ‘gross-net’), (ii) accounting for FM under Article 3.4 is now mandatory (and ‘net-net’ with a cap of 3.5 % of 1990 total GHG emissions excluding LULUCF), (iii) accounting for cropland management, grassland management, revegetation under Article 3.4 is still voluntary (and ‘net-net’), and (iv) a new activity appears under Article 3.4: wetland drainage and rewetting (voluntary and ‘net-net’).

For the specific case of Article 3.4 FM, accounting for carbon storage in HWP is now possible, while emissions due to natural disturbances can be discounted, if certain specific guidelines are followed. Forest GHG emissions and removals accounting procedures 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 and (iii) using adequate Tier and Approaches, according to a Key category analysis. However, LULUCF accounting presents specific challenges, especially related to tracking land-use changes according to the activities defined in Articles 3.3 and 3.4 of the Kyoto Protocol.

8.4.2 Issue Surrounding the Definition of Forest in Turkey

Turkey uses a national definition of forest in its annual submissions to the UNFCCC. According to the Forest Law number 6831, the national definition of forest is as follows:

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).

However, a new definition of forest has to be used for calculations under Articles 3.3. and 3.4. In accordance with the request made in Article 16 of the

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

8.4.3 *Perimeter of the Cost Benefit Analysis*

The UNFCCC and its KP are focusing on the GHG emissions and removal, but had considered it interesting to estimate the impacts of policies and measures on other forest amenities. In that context, the numbers used in calculating the total economic value (TEV) mainly rely on Pak et al. (2010), with crosschecking of data from Turker et al. (2005) and Ok et al. (2013). The definitions of the main components are as follow (all definitions are extracted from Pak et al. (2010), with further details if underlying quotations are used):

- *Use value*: Benefit that an individual obtains directly by directly using the natural resource, e.g. values associated with outdoors recreation (Adamowicz 1995). Use values are divided into
 - *Direct use value*: This includes consumptive uses, e.g. felling and hunting, and non-consumptive uses, e.g. hiking, camping and boating (Fausold/Lilieholm 1996);
 - *Indirect use value*: This can be illustrated by reading books related to the natural resource or watching television programs about wildlife (Fausold/Lilieholm 1996);
 - *Option value*: Value of a resource that will be possibly spoiled in the future (Kula 1994);
- *Non-use value*: Value estimated for natural resources although they are not in fact used. Non-use values are divided into
 - *Existence value*: This is the value placed on an amenity even though individuals may never use or visit it; however, it is important for them to know that it will continue to exist (Klemperer 1996; Condon/Adamowicz 1998);
 - *Bequest value*: This refers to the willingness to pay to preserve some resource for future generation (Klemperer 1996).

These different values have been estimated in Turkey using the valuation techniques presented in Table 8.2.

Table 8.2 Valuation techniques to estimate the TEV of forests

Externally-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	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

Source Merlo/Croitoru (2005)

8.5 Results and Discussions

8.5.1 *Current Key Facts and Figures About Turkey's Forests*

The Ministry of Forestry and Water Affairs (MFWW) stands as Turkey's highest authority in Forestry. It is primarily responsible (in terms of forestry) 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, which have the following tasks and responsibilities:

- GD for Forestry (OGM-Turkish acronym) is the main unit for the FM. It has 27 Regional Directorates and 217 District Directorates at the field level;
- GD for Desertification and Erosion Control (ÇEM-Turkish acronym) holds the primary responsibility for combating desertification and erosion of all classes of land, particularly eroded or degraded areas;
- GD for Nature Conservation and National Parks (DKMPGM-Turkish acronym) 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 Turkey's total land area, but only about 53 % of the forests is designated as 'productive' forests, while the remaining 47 % is made up of 'degraded' or 'unproductive' forests. Besides these areas, sizeable areas corresponding to more than 40 % of the country, such as rangelands in or around forests, shrub lands, maquis shrub lands, and open alpine lands are considered part of the forest resources on technical grounds. These resources are mainly located in mountainous areas (Haase 2011).

The OGM specifies six subcategories of forest: (i) coniferous (around 76 % of the area of pure high forest), (ii) deciduous forest (around 24 %), (iii) productive forest (more than 10 % forest cover; 53 % of the total forest area), (iv) degraded forest (between 1 and 10 % forest cover; 47 % of the total forest area), (v) high forests (80 % of the total forest area) and (vi) coppices (20 %). Total respective areas are as given in Table 8.3. Several concerns have been raised about the national definition of forest.

8.5.1.1 **Managed and Unmanaged**

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 conducted (duration of 10–20 years) on productive forests and

Table 8.3 Shares of productive versus degraded, coniferous versus deciduous, high forests versus coppices

	Pure high forest		Mixed high forest	Total high forest	Coppices	Total	%
	Coniferous	Deciduous					
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	

Source OGM (2012)

10 272 000 ha of this area under management would be revised by 2020 for a moderate cost, i.e. 5.42 TL/hato 28 TL/ha. A total of 55 ‘conservation forests’ (251 409 ha) are also considered as ‘managed’ forests by OGM (pers. com. Mehmet Ceylan; FM and Planning Department of OGM, February 2014).

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

Various reports also mention the existence of ‘unmanaged forest’: (i) ‘4.1 Mha of the total forests (19 %) comprising national parks, protected areas and other kinds of abandonment areas that 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, which 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 2011). In total, these ‘unmanaged’ or ‘non-commercial’ forests could encompass 0.9 Mha, 2.2 Mha, or even 4.1 Mha. This amount, and discrepancy in measurements, have some consequences in terms of the GHG’s inventory;

8.5.1.2 Legal Boundary (Cadaster) and Technical Boundary (Management Plan)

“When cadaster and boundary marking activities are completed, in the size of legal forest areas is estimated to be crucial increments [...] For example, a 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 cadaster deployment is still on-going and the boundaries of FM plans are revised accordingly when they are renewed (every 10–20 years) (com. pers. Selda PAS—GIS Division of Information System Department of OGM, February 2014). Knowing that forest areas are regularly monitored using the FM plans (compiled in the Forest Inventory and Statistical

Database; ENVANIS) and that these areas are used in the GHG inventory, such revisions also have some consequences on the latter.

8.5.1.3 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/year) and a conservative assumption of volume increment (Iv) of 10 m³/ha/year for these fast-growing species, private plantations would cover at least 0.33 Mha of land in 2003. 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 is not clear by which method these private plantations (poplar plantations on the one hand, considered as agriculture land in Turkey; other private plantations on the other hand, considered as forest land in Turkey) were considered in the GHG inventory, this lack of clarity also has some consequences on the latter.

8.5.2 Historical Changes in Forest Areas

Two National Forest Inventories (NFI) were conducted, one in 1972 and one in 2004. Between these dates, the forest area increased by 0.99 Mha, i.e. +0.15 %/year. 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 × 300 m) of circular plots ranging in size from 400 to 800 m², depending on crown cover. It compiles data from FM units and classifies stands according to three criteria: species mix, crown closure and age classes. Therefore, it allows the calculation of changes in area, volume increment and stock on a year-by-year basis.

It is possible to draw an historical data series of the ‘forest area’ (in line with the national definition) using FAO FRA 2010 data for the years 1972 (NFI conducted by OGM), 1996 (partial NFI conducted by OGM), 1999 (report on ‘Forests and Turkish Forestry’ by Mr Konukçu), 2004 (NFI conducted by OGM) and 2004 to 2010 (ENVANIS data compiled by the OGM), and then adding the following land use types:

- Forest Land (FL): Area > 0.5 ha; Tree height > 5 m; Tree canopy cover > 10 %; land predominantly under agricultural or urban land uses is not included. This FAO definition of FL is equivalent to the national definition of ‘productive forest’ (which can be high forest or coppice);

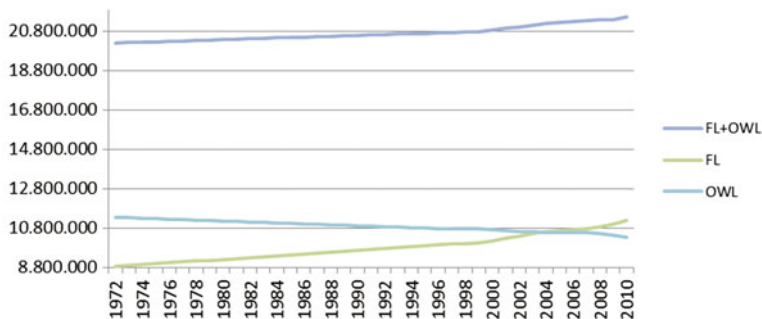


Fig. 8.2 Changes in FL and OWL areas (ha), 1972–2020. *Source* Bouyer (2014) based on FAO FRA (2010)

- Other Wooded Land (OWL): Land not classified as forest; Area > 0.5 ha; Tree height > 5 m; 5 % > Tree canopy cover > 10 %, or combined cover of shrubs, bushes and trees > 10 %; land predominantly under agricultural or urban land use is not included. 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 1–10 % of tree cover, the area of degraded forest is bigger than that of OWL (with tree cover between 5–10 %).

Estimates for 1973 through 1995 were possible through linear interpolation of the data for 1972 and 1996. Estimates for 1997 through 2003 were possible through linear interpolation of the data for 1996 and 2004. Changes in FL and OWL areas from 1972 to 2010 are given in Fig. 8.2.

It is important to note that (i) the total forest area (FL + OWL) increased by 1.34 Mha between 1972 and 2010 and (ii) the FL area increased over the same time frame, whereas the OWL area decreased. Assuming a theoretical linear trend, the FL area would be 11.8 Mha by 2020 (compared with 8.9 Mha in 1972) and the OWL area would be 10.1 Mha by 2020 (compared with 11.3 Mha in 1972). On average, for 1990–2010, FL increased by 76 161 ha/year (conversion of OWL and other land uses to FL by regeneration + plantations).

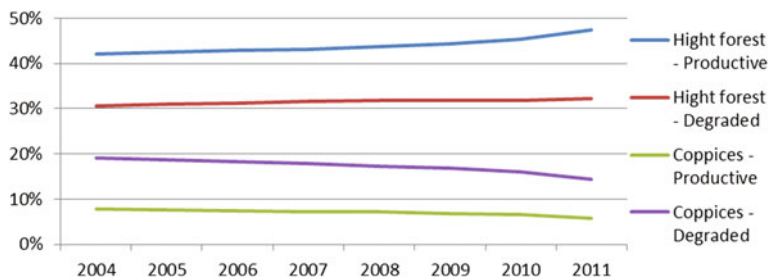


Fig. 8.3 Area changes (%): High forest versus coppices, productive versus degraded from 2004 to 2011. *Source* OGM (2012)

Focusing on forest area changes from 2004 to 2011 and using ENVANIS data, it is important to note that (i) the area of coppices is decreasing whereas that of high forests is increasing and (ii) the area of degraded forest is decreasing, whereas that of productive forest is increasing. These changes are shown in Fig. 8.3.

8.5.3 *Historical Rates of Afforestation and Reforestation*

In the FAO FRA 2010, various types of A/R are considered but only a certain percentage of each area is ultimately 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 judgements, aims to take three salient facts into consideration (com. pers. Yücel Fırat—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: i.e. hedges and small patches
- The rate of survivals depends on the type of plantations conducted, which in turn depends on 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, i.e. small patches, hedges, etc., and therefore, private afforestation is assumed to be done conducted on agricultural land.

OGM data series (compiling data from OGM, and AGM, but also other public services and A/R made by the private sector) have been available since 1947 and use the same categories as those used in FAO FRA 2010, apart for two categories: (i) ‘artificial regeneration’ is reported under ‘afforestation’ by the OGM and (ii) ‘range improvement’ is used by OGM but not the FAO categories; such areas are instead reported under ‘erosion control’ in FAO FRA 2010.

Nonetheless, the two set of ‘reclassified’ data series are consistent: if ‘raw’ A/R is 198 774 ha/year over 1990–2013 for OGM and 174 014 ha/year over 1990–2010 for FAO, then ‘reclassified’ A/R is 87 512 ha/year over 1990–2013 for OGM and 81 996 ha/year over 1990–2010 for FAO. Thus, a difference of slightly less than 7 % exists between the two data series, in favor of OGM. In addition, as OGM data series are complete over time and documented by various archives, these data series are used in our calculations. Figure 8.4 depicts the reclassified A/R, using two different scales: one for rehabilitation and one for the other types of A/R.

“According to a survey conducted by AGM in 1999–2000, potential areas for afforestation, erosion control and range improvement are 2.4 Mha, 1.4 Mha and 0.8 Mha, respectively, (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

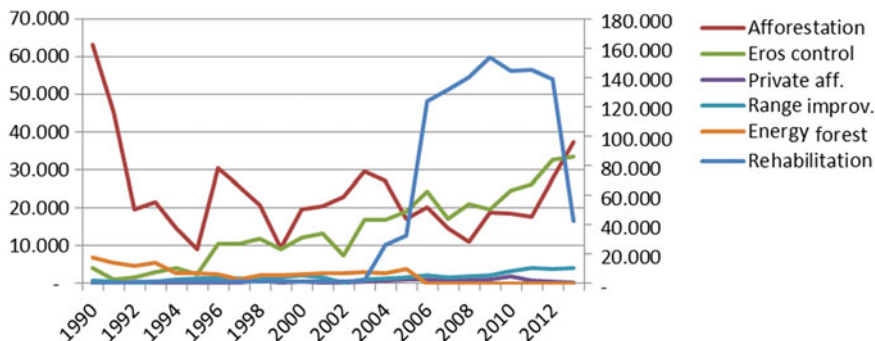


Fig. 8.4 Changes in A/R (ha/year) from 1990 to 2013. *Source* Bouyer (2014) based on OGM (2014)

covered by the mentioned activities. This means that approximately 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 height > 5 m; Tree canopy cover > 10 %, consisting mainly of fruit trees and olive trees in Turkey) are mentioned for years 1990, 2000, 2005, 2006, 2007, 2008 and 2010 in the FAO FRA 2010. However, (i) it is mentioned that fruit and olive tree areas were only recorded for three years, namely 2000, 2005 and 2010 by TurkStat (2013), and (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.

8.5.4 Harvests and Damage in Managed Forests

As can be seen in Fig. 8.5, harvests were high in the 1970s (above 20 Mm³, roughly 75 % firewood). From there, it decreased to its lowest level at the beginning of the 2000s (12.5 Mm³/year in 2001), before rising again through the present day. It is worth noting that firewood harvests fell steadily, whereas industrial round wood harvests, which had remained stable from the 1970s to the 2000s (around 7 Mm³/year), showed a sharp increase afterwards.

The main explanations for these trends are as follows. For industrial round wood, “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 2011) for firewood, numerous reports point out the massive rural exodus, which can explain the decrease in demand. ‘Firewood is assumed to be harvested only in productive forest and no harvesting of industrial round wood is reported for degraded forests’ (NIR 2013).

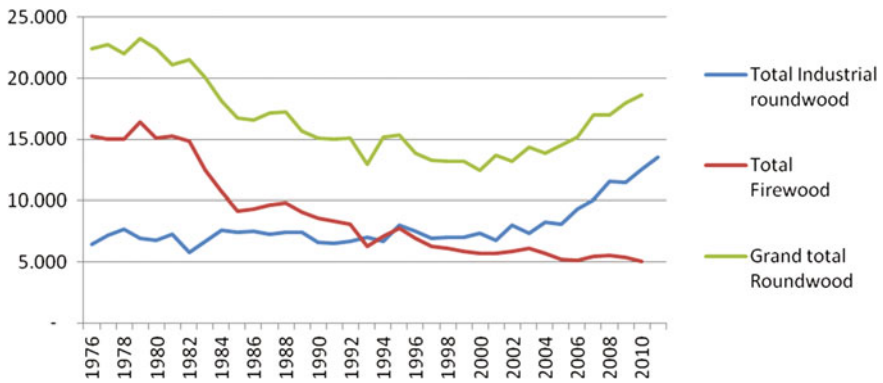


Fig. 8.5 Annual harvest (industrial round wood and firewood) in thousands of m³ from 1976 to 2011. *Source* OGM (2014)

During 2007–2011, the average total harvest was 17.2 Mm³ (45 % of the total volume increment, according to ENVANIS data 2014), made of 77 % coniferous and 23 % deciduous. This could be divided into 69 % industrial round wood and 31 % firewood. After firewood, logs (third quality for 98 % of the volume) are the main product (29 % of the total harvest, of which 18.5 % is coniferous and 5.5 % is 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).

Turkey is a Mediterranean country and wildfires are very common except in winter. “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 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).

Figure 8.6 presents historical data regarding forest fires (extracted from the forest fires database of the OGM’s Forest Fire Department). NB: Since the fire monitoring system was changed in 2005 to enable better recording of forest fires, data before 2005 may be underestimated (pers. comm. Uğur Baltacı; Meteorology Division of Forest Fire Department of OGM, February 2014).

High levels of variability can be observed for both number of fires and area per fire. Comparing the average area burned, number of fires, and area per fire for the

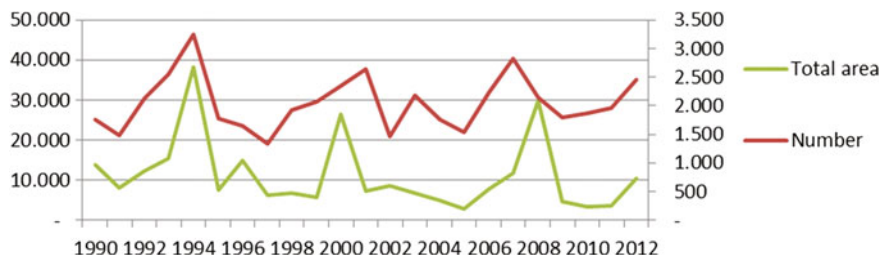


Fig. 8.6 Number of fires and area per fire (ha) from 1990 to 2012. *Source* OGM (2014)

periods 1990–2000 and 2000–2012 reveals a decreasing trend in terms of burned area (−390 ha/year), area per fire (−0.4 ha/year), and number of fires (−6.2 fires/year) (Table 8.4).

As most fires are illegal, scattered over a huge territory and therefore difficult to control, it seems reasonable to assume that the number of fires 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 the 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 burned areas 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. Uğur Battacı; Meteorology Division of Forest fire Department of OGM, February 2014).

One other major source of damage concerns the insects. Two major insect outbreaks in terms of affected areas can be identified. The first is an infestation of *Thaumetopoea pityocampa* (Schiff.), which spread over 2 204 000 ha of *Pinus brutia* and *Pinus nigra* (Arnold.) between 1997 and 2001. The next most severe infestation was caused by *Dendroctonus micans* (Kug.), which spread over

Table 8.4 Changes 90/00 versus 00/12: burnt area (ha), number of fires and area (ha) per fire

	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 etc. 00/12	−4 294	68	−3.9
Annual change*	−390	6.2	−0.4

Source OGM (2014)

*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

990 000 ha of *Picea orientalis* (L.) between 1996 and 2001 (FAO FRA 2010). Compared with fires and insects, both diseases as well as abiotic factors appear marginal in terms of afforestation.

8.5.5 Projections for A/R and D Activities (Article 3.3)

The OGM strategic action plans aim at increasing the forest cover to 30 % of the country (i.e. 23.5 Mha) by 2017. It foresees reaching the following milestones between 2013 and 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 and apply the same rates of reclassification as previously presented, then the 256 800 ha/year of ‘raw’ A/R foreseen by OGM over 2013–2017 would convert into 122 872 ha/year of ‘reclassified’ A/R over 2013–2017. Considering an ‘informal’ objective of 50 000 ha/year of ‘raw’ A/R after 2017 to 2020 (as expressed by the participants of the inception workshop to this study, February 2014), which would convert into 23 925 ha/year of ‘reclassified’ A/R over 2018–2020, we can project A/R rates of A/R up to 2020: the 1990–2020 average would then be 83 509 ha/year.

To prepare the specific LULUCF calculations, we then assume that A/R species are selected in accordance with the current forest composition, 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).

These data and calculations thus yield four data series over 1990–2020: A/R ext, con = 49 069 ha/year, A/R int, con = 18 816 ha/year, A/R ext, dec = 11 294 ha/year, A/R int, dec = 4 331 ha/year. Cumulative A/R would then be 2 588 794 ha over 1990–2020. 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/year if divided by 22 years. Knowing that the cumulative area of A/R (calculated previously) is 1 909 908 ha over the same period, i.e. 86 814 ha/year, then the difference 86 814 ha/year – 85 439 ha/year = 1 376 ha/year can be estimated as the amount of deforestation that occurred over this time frame.

As ENVANIS does not record deforestation area, even if OGM staff generally recognizes its existence, we then apply this amount of deforestation conservatively over the remaining period, 2012–2020. Figure 8.7 shows the resulting calculations.

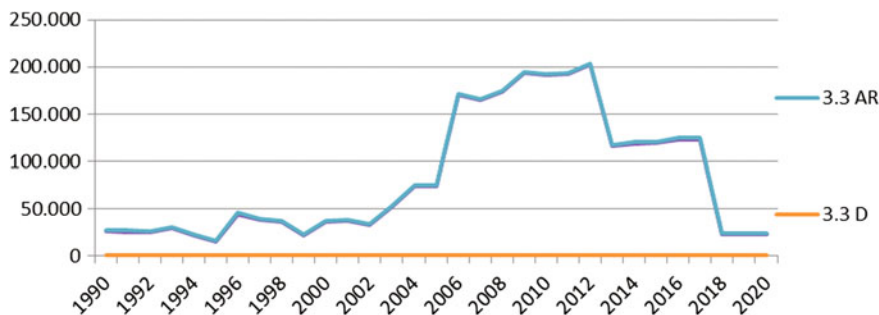


Fig. 8.7 Estimated 1990–2020 data series for 3.3 A/R and 3.3 D. Source Bouyer (2014)

8.5.6 Projections for FM (Article 3.4)

To prepare the specific LULUCF calculations, we estimate data series covering 1990–2020 for the main forest types to be considered under 3.4 FM. The estimation procedure entails the following 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 should be accounted for under Article 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 found in 1990. Therefore, the area considered under 3.4 FM is 9 638 348 ha in 2020, with 41 266 ha deducted from the initial area equal to the deforestation over 1990–2020. We thus have a complete 1990–2020 data series for the 3.4 FM area;
- *Area of the forest.* We interpolate the 1990–2002 data for the forest area using the FAO FRA data for 1990 and ENVANIS data for 2002. We estimate the data series 2013–2020 for the forest area by adding the net A/R = A/R – D over year, starting in 2012 to produce a complete forest area data series for 1990–2020;

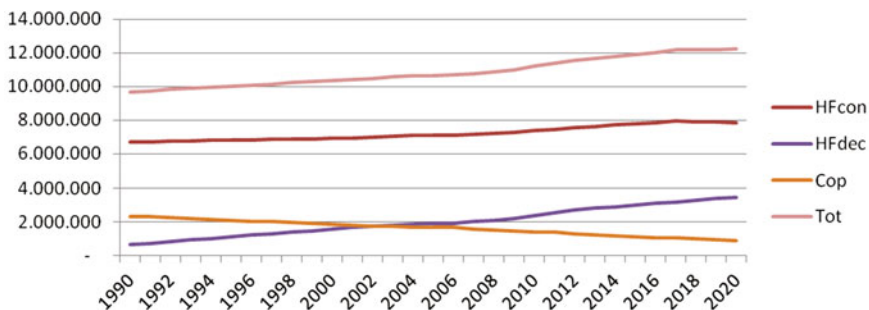


Fig. 8.8 Estimated 1990–2020 data series for forest area (ha), by forest types. Source Bouyer (2014)

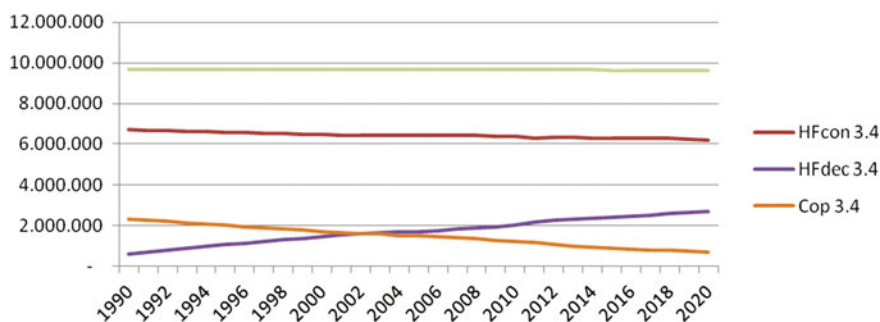


Fig. 8.9 Estimated 1990–2020 data series for 3.4 FM area (ha), by forest types. *Source* Bouyer (2014)

- *Areas of the main forest types.* The three main forest types identified in ENVANIS are high forest coniferous, high forest deciduous and coppices. Using the data series for these three forest types over 2002–2012, we extrapolate these data series back to 1990 and forward to 2020. This yields complete data series for 1990–2020 for forest type areas. The result is shown in Fig. 8.8.
- *Areas of 3.4 FM disaggregated by main forest type.* This step was conducted using the rule of three as follows: area of 3.4 FM forest type A = area for forest type A × (area for 3.4 FM/area for forest), we have complete data series 1990–2020 for 3.4 FM forest type areas. Figure 8.9 shows the results of these calculations.

Using the estimates for D (in tdm/m^3) and BEF1 (dimensionless) for the main forest types, and the stocks (in m^3/ha) reported in the NFI for 1972 and 2004 (useful only for coppices, as the NFI 1972 and 2004 did not specifically report stocks and areas for coniferous and deciduous forests) as well as the ENVANIS database for 2011, we estimate the stocks (in td m^3) using the following equation: S (tdm/ha) = $S(\text{m}^3/\text{ha}) \times D \times \text{BEF1}$. Table 8.5 shows the results.

Table 8.5 Estimates of stocks (in tdm/ha) for the three main forest types

	NFI 1972	NFI 2004	ENV 2011	Default value Table 3A. 1.2 (GPG 2013).	Value retained
S (m^3/ha) in Hfcon (ENVANIS)			121.6		
S (tdm/ha) in Hfcon			56.2	134	56.2
S (m^3/ha) in Hfdec (ENVANIS)			145.6		
$S(\text{m}^3/\text{ha})$ in Hfdec			100.6	122	100.6
S (m^3/ha) in Cop (ENVANIS)	33.0	41.9	41.0		
S (m^3/ha) in Cop	17.7	22.5	22	128	18.8

Source Bouyer (2014)

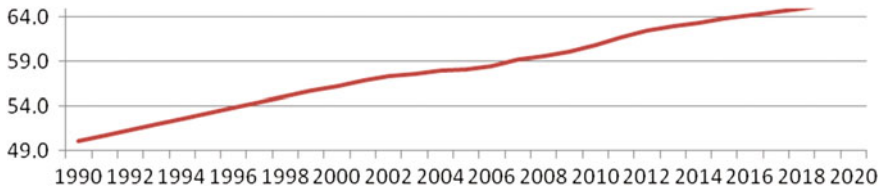


Fig. 8.10 1990–2020 data series of the average stocks (tdm/ha) in Turkish forests. *Source* Bouyer (2014)

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

We next used these estimated stocks together with the estimated data series of 3.4 FM areas for the three main forest types to estimate the 1990–2020 data series for average Turkish forest stocks, taking into account the respective stocks and evolution of the three main forest types. The results are shown in Fig. 8.10. Note that the average stock amount is estimated to increase by 24 % from 1990 (50.1 tdm/ha) to 2020 (66.1 tdm/ha), i.e. 0.8 %/year.

8.5.7 Projections for Harvests

The following analysis will mainly focus on 3.4 FM. Indeed, A/R harvests made after December 31, 1989—to be considered under 3.3 A/R—are very limited: the first thinning comes only after 15–20 years and only 15–40 % of the trees are harvested (personal Communication, Uğur Tüfekçioğlu; Head of the Forest Maintenance Division of OGM, February 2014). Therefore, the calculations made for 3.3 AR include a uniform thinning of 20 % of the trees after 15 years, which appears to be a conservative assumption.

Returning to 3.4 FM, the following analysis considers two options:

- *Extensive scenario.* Considering only the effective thinning of forests, then according to management plans prescriptions, a 25 Mm³ increase of total round wood production would be possible by 2020, according to OGM. This would imply an intermediate objective of 21 Mm³ by 2017 (personal Communication, 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 was intended to increase industrial round wood production by OGM to 90 Mm³ over 2010 and 2014 (i.e. 18 Mm³/year). However, the production fell short of this objective. Even though no specific figures are given in

the OGM 2013–2017 Strategic Plan, the same increase (18 Mm³/year) is still predicted for 2013–2017 (personal communication. 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 depend on market conditions, and OGM staff did not want this objective to be set in stone.

In the extensive scenario, we estimate the following:

- *Firewood*. Illegal harvests, private sector production and consumption are assumed to follow linear trends (extrapolation from the respective historical data series). Import–export, already very reduced, is assumed to be nil. Then, we would assume that OGM harvests of firewood are set to match consumption. The OGM firewood harvest would then be 2.6 Mm³/year by 2020. Figure 8.11 shows these projections (expressed in thousands of m³/year).
- *Round wood*. Illegal harvests and private-sector production are assumed to follow linear trends (extrapolation from the respective historical data series). OGM harvests are supposed to be 21 Mm³ in 2017 and 25 Mm³ in 2020 (harvests for the years are estimated by interpolation). Total production is calculated as illegal harvest + private sector + OGM. Consumption is also assumed to follow a linear trend (extrapolation from the historical data series). Import–export is then estimated by deducting production from consumption. Figure 8.12 shows the projections (expressed in thousands of m³/year).

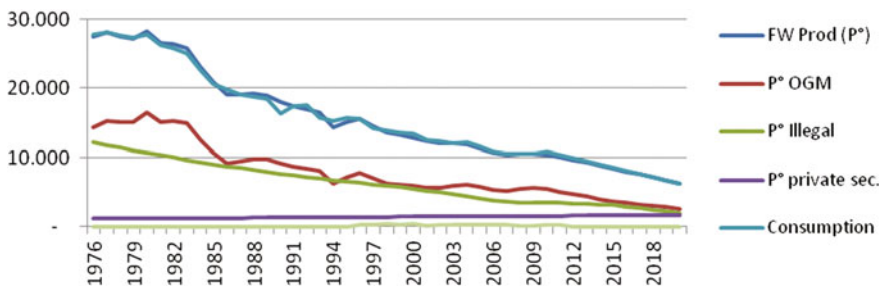


Fig. 8.11 2020 projections of firewood production and consumption in the extensive scenario. Source Bouyer (2014)

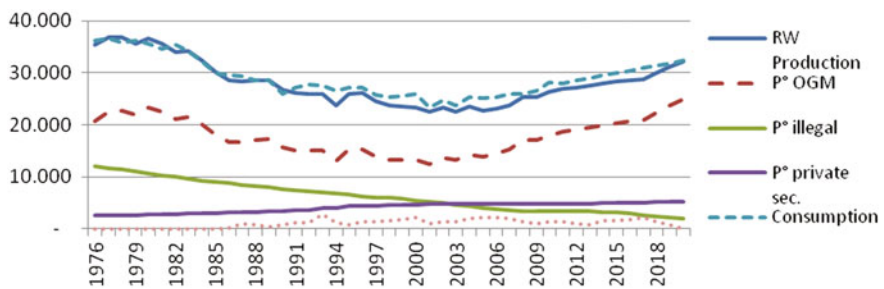


Fig. 8.12 2020 projections of round wood production and consumption in the extensive scenario. Source Bouyer (2014)

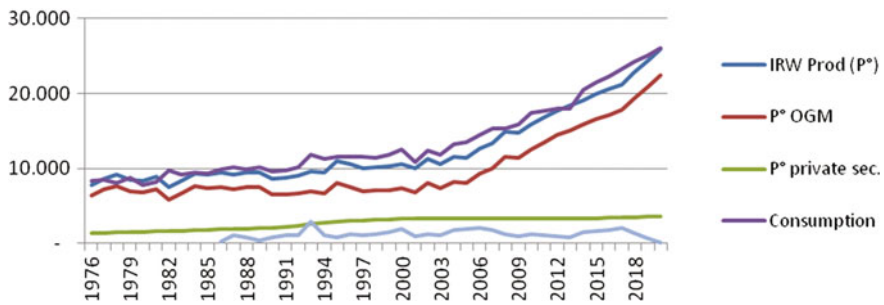


Fig. 8.13 2020 projections of industrial round wood production and consumption in the extensive scenario. *Source* Bouyer (2014)

- *Industrial round wood.* Private sector production is assumed to also follow a linear trend (extrapolation from the respective historical data series). Illegal harvests are assumed to be nil (as already assumed by OGM). The OGM harvest of industrial round wood amounts to the difference between its total harvest and its firewood harvest. Consumption of industrial round wood is calculated as the difference between total consumption and firewood consumption. Production is estimated by adding OGM production and private sector production. Import–export of industrial round wood is equal to total import–export (import–export of firewood being nil). Figure 8.13 shows the projections (expressed in thousands of m³/year).

In the intensive scenario, we estimate the following:

- *Firewood.* This subscenario is the same as in the extensive scenario (increased production does not impact domestic demand, which is inelastic to the supply);
- *Round wood.* Assuming OGM harvests 90 Mm³ of industrial round wood from 2013 to 2017, OGM production of industrial round wood is estimated to gradually increase, from 14.7 Mm³ in 2013 to 16 Mm³ in 2014, 18 Mm³ in 2015, 20 Mm³ in 2016 and 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.

By knowing OGM production levels of industrial round wood and firewood, its total production of round wood can be calculated. Then, assuming that private sector production of round wood follows a linear trend (extrapolation from the historical data series) and knowing that the illegal sector production of round wood is equal to its production of firewood, the total production of round wood is known through the following calculation: levels of production of OGM + private sector + illegal harvest.

Then, assuming that the consumption of round wood will also follow a linear trend, import–export is calculated by subtracting consumption from production. It is worth noting that, under this intensive (and ambitious) scenario, Turkey is assumed to be a net exporter of round wood. Figure 8.14 shows the projections (expressed in thousands of m³/year):

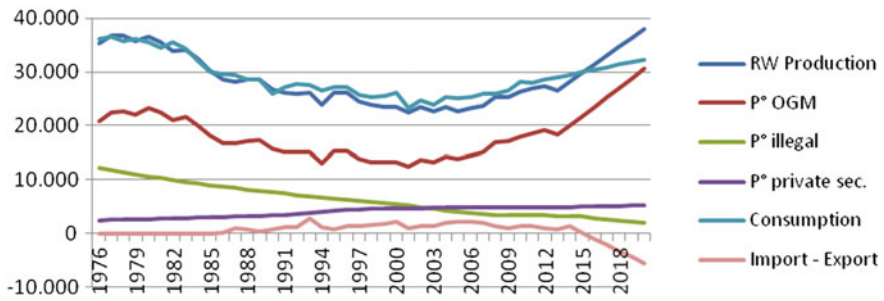


Fig. 8.14 2020 projections of round wood production and consumption in the intensive scenario. *Source* Bouyer (2014)

- Industrial round wood.* Estimated OGM production of industrial round wood follows the scenario presented above (Sect. 5.7). Import–export of industrial round wood is equal to total import–export (with import–export of firewood being nil). Private-sector production of industrial round wood is calculated as the difference between total harvest and firewood harvest. Consumption of industrial round wood is calculated as the difference between total consumption and firewood consumption. Production is estimated by totaling OGM production and private sector production. Figure 8.15 presents these projections (expressed in thousands of m³/year):

Having estimated two 1990–2020 data series for round wood production for OGM, one extensive (25 Mm³/year by 2020) and one intensive (29 Mm³/year by 2020, 4 Mm³/year more compared with the other). We then allocate this harvest among the three main forest types.

Indeed, we know the permitted cut for 2002–2012 (ENVANIS 2013), which is divided among high forest coniferous and high forest deciduous (99.9 % of industrial round wood; therefore, firewood harvests in high forest areas are neglected order to simplify the calculations) on the one hand and coppices (100 %

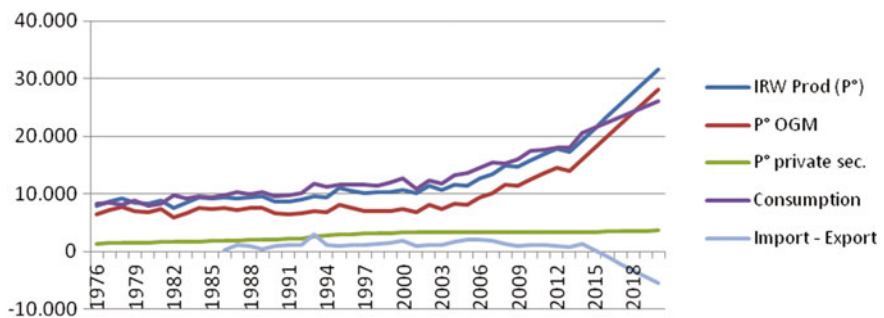


Fig. 8.15 2020 projections of industrial round wood production and consumption in the intensive scenario. *Source* Bouyer (2014)

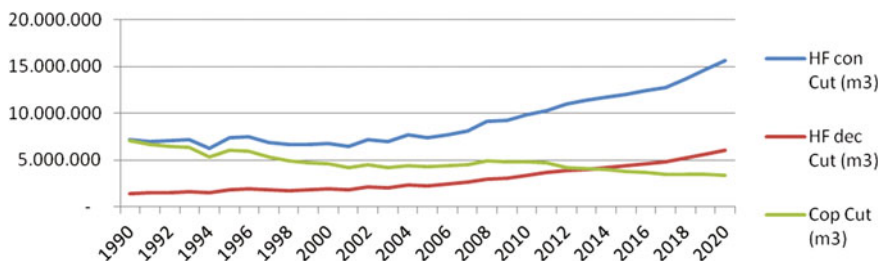


Fig. 8.16 2020 projections of harvest per forest types in the extensive scenario. *Source* Bouyer (2014)

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.

Next, we extrapolate the shares (in %) of total harvest for the three main forest types for 1990–2001 and 2013–2020 using 2002–2012 ENVANIS data. Then, we allocate the estimated 1990–2012 data series for harvests using the estimated percent of harvest for each forest types. Figures 8.16 and 8.17 show the results (expressed in thousands of m³/year):

At the inception workshop to this study, a debate arose about the development of bioenergy and its possible impact in terms of harvests. Indeed, in addition to the use of ‘traditional’ firewood by forest villagers and the rural population in general, some documents point to the potential development of pellets for use in industrial power plants.

- “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 2011). During this workshop held in Kastamonu, in February 2010, the OGM declared that ‘we expect that much of the extra 5 Mt/year of

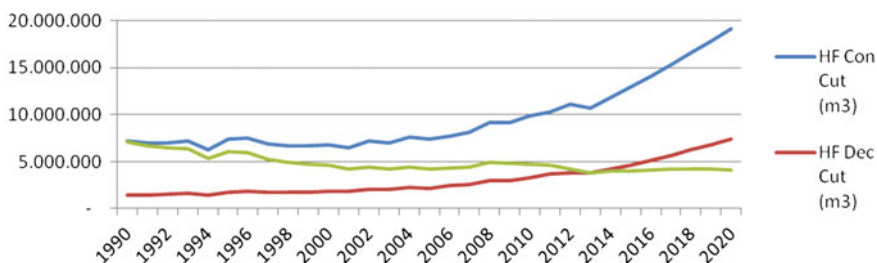


Fig. 8.17 2020 projections of harvest per forest types in the intensive scenario. *Source* Bouyer (2014)

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 terms ('extra') and since the 'baseline' level is not specified;

- 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 considering the assumptions already presented (see default values for the BCEF from Table 5.4 of the FAO FRA 2010 Guidelines), the firewood harvest in 2020 can be estimated for the main forest types: 6.73 Mm³ (8.58 Mtdm × 59 % × 1.33 tdm/m³) in coniferous forests; 1.55 Mm³ (8.58 Mtdm × 19 % × 0.95 tdm/m³) in deciduous forests and 2.25 Mm³ (8.58 Mtdm × 23 % × 1.14 tdm/m³) in mixed forests. In total, the BALANCE projection leads to a total firewood harvest of 10.53 Mm³/year in 2020, i.e. 67 % more than the projections made under either the intensive or extensive scenario.

According to inception workshop participants, the BALANCE projection is no longer pertinent. Indeed, the Scientific and Technological Research Council of Turkey (TÜBİTAK) conducted a feasibility study into the development of an industrial biomass plant. This study concluded that electricity production from forest biomass is only feasible for plants over 20 MW. But OGM realized it is not logistically or economically feasible to provide such large amounts of biomass. OGM was initially looking for plants of one to two MW. Therefore, the pilot plant discussed in the TÜBİTAK project was not installed and the objective of developing an industrial biomass value chain was abandoned.

8.5.8 *Biotic and Abiotic Damage*

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

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

Therefore, this study only concentrates on the projection of forest fires through 2020 to estimate the related biomass loss. This exercise is difficult and subject to

discussion since some of the factors determining the impact of forest fires can be controlled, whereas other cannot. For instance:

- The number of forest fires started due to negligence might be reduced by increasing information and prevention measures, but such measures will have limited effect on criminal forest fires;
- The ability to stop forest fires in the crucial first 20 min can be improved using a real-time fire alert system (as does OGM) and making sure the firemen arrive on site as fast as possible;
- Whatever efforts are made in terms of prevention, measures such as a fire alert system, forest firefighting equipment, etc. will not enable the avoidance of large forest fires if natural conditions are conducive (e.g. firemen often refer to the rule of the '3 × 30': when air humidity is below 30 %, wind speed above 30 km/h, and ground temperature above 30 °C, there are few chances to stop a forest fire).

This being said, we forecast future forest fire trends as follow:

- *Area per fire*: The average area is 4.6 ha/fire over the period 2000–2012. This rate could be reasonably decreased to 2.5 ha/fire by 2020 (personal Communication, Uğur Battacı, Meteorology Division of Forest fire Department of OGM, February 2014, corroborated by personal communication, 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 the period 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;
- *Number of fires*: The number of fires between 2013–2020 is set equal to the average over 2000–2012, i.e. 2 072 fires/year.
- *Area burned*: The burned area is equal to area per fire × number of fires. A decreasing trend can be identified, up to 5 180 ha in 2020. The average over 2013–2020 is 7 063 ha, which is 28 % below the average during the 2000–2012 period (9 834 ha). This projection seems ambitious, but considering the progress made by OGM's Forest Fire Fighting Department over the last two decades, it seems achievable.

8.5.9 Accounting Carbon Credits for 3.4 FM

Having calculated the required values, we can now estimate net removals including HWP for the 1990–2020 time series for the two scenarios. The results are shown in Fig. 8.18, expressed in MtCO₂eq/year of net removals.

Based on these results and considering the upgraded LULUCF accounting rules for Article 3.4 FM as well as the *Synthesis Report of the Technical Assessments of the FM Reference Level (REL) Submissions* published in November 2011 by the UNFCCC Secretariat, we can envisage five different possible interpretations for the

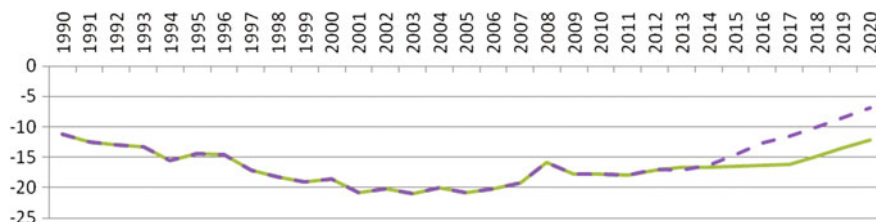


Fig. 8.18 1990–2020 net removals in 3.4 FM area under intensive vs extensive scenarios. *Source* Bouyer (2014)

Table 8.6 Five different RELs for Article 3.4 FM in Turkey and numerical consequences

All numbers in MtCO ₂ eq	Number of Annex 1 Parties	Corresponding REL in Turkey	Difference if		Removal Units	
			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 (tCO ₂ eq/yr)		188.4		Cap of 3.5 %	-52.8	

Source Bouyer (2014)

elements of footnote 1 in Annex of 16/CMP.1 in order to set the REL for Article 3.4 FM in Turkey.

Five proposed RELs are possible (Table 8.6). 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 part of the projected REL (see elements of footnote in Annex of 16/CMP.1).

8.5.10 Accounting Carbon Credits for 3.3 A/R/D

The previous calculations can also be used to estimate net removals due to A/R and D for the 1990–2020 time series. The results are shown in Fig. 8.19, expressed in MtCO₂eq/year of net removals.



Fig. 8.19 1990–2020 net removals due to A/R and D. *Source* Bouyer (2014)

Based on these results and considering the upgraded LULUCF accounting rules for Article 3.3 ARD, 119.4 million of RMUs would be generated under this Article between 2013 and 2020. According to Article 3.3, an estimated 119.4 million of RMUs will be generated between 2013 and 2020, which is more than two times the maximum amount of RMUs to be generated under Article 3.4 FM.

8.5.11 *Operation and Transaction Costs*

The operation and transaction costs associated with Article 3.3 and Article 3.4 were estimated using the following approach:

- For Article 3.4, operation costs are equal to FM costs, which converts to 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, totaling 66.7 US\$/RMU;
- For Article 3.3, the operation cost comprises plantation costs (for years 1 to 4) and FM costs (from year 5 onward) and amounts to 86.4 US\$/RMU;
- For Article 3.3 and Article 3.4, transaction costs mainly comprise upgrading the current LULUCF inventory. They are assumed to be marginal, around 1.2 MUS \$ in total as most of the data sources are already available and the main efforts required are in terms of human resources. Transaction costs would therefore range from 0.01 to 0.007 US\$/RMU.

8.5.12 *Quantification of Non-carbon Benefits*

The most recent estimates for the TEV of Turkish forests are given in Table 8.7.

Comparing these values with other existing estimates is quite difficult since these other estimates were either classified by economic agents (e.g. percent of GNP for the state, wages for the forest workers, and revenue and forest livelihood for the forest villagers) or were not based on the same perimeter (e.g. most of the estimates

Table 8.7 Disaggregation of the TEV of the Turkish forests

TEV components	Type of outputs	Value (US \$) per year		%	
Direct use values	Wood based forest products	1165178097.46	68.35		
	Non-wood forest products	454292.02	0.03		
	Grazing	225000000.00	13.20		84.03
	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 converse biodiversity)	1380000.00 1704810889.48		0.08	
Positive TEV components		1704810889.48		100.00	
Negative externalities	Erosion	-125000000.00		93.56	
	Risk of damage by forest fires	-8607537.00		6.44	
Negative TEV components		-133607537.00		100.00	
Net total economic value of Turkish forests		1620459352.58			

Source Pak et al. (2010)

for NWFPs are only considering the OGM revenue and not the overall revenue for OGM + middlemen + forest villagers). These discrepancies highlight the crucial need to try, as much as possible, to use common terminologies and assumptions when valuing forest amenities.

Accordingly, if we compare the data from Pak et al. (2010) with other data sets, we can determine the following amounts:

- *Wood-based products*: This estimate (roughly 1.17 trillion US\$/year) is considerably higher than the values of 0.45 trillion US\$/year from Bann/Clemens (2001), quoted in Türker et al. (2002, 2005), as well as the value of 0.86 trillion US\$/year from Ok et al. (2013). Indeed, this estimate is more recent (more felling occurred than that in 2001, explaining the difference with Bann/Clemens (2001)) and considers a larger perimeter than the sole OGM wood-based products (existence of private felling explains the difference with Ok et al. (2013)). It therefore appears reasonable to use this estimate.
- *NWFPs*: This estimate (roughly 0.45 MUS\$/year) appears extremely low compared with 86 MUS\$/year from Bann/Clemens (2001), quoted in Türker et al. (2002, 2005). It is roughly three times less than the 1.35 MU\$/year from Ok et al. (2013), but this latter one may itself 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 of roughly 335 MTL in 2012 and 514 MTL in 2013, considering OGM revenue + middlemen revenue + forest villagers' revenue. Once averaged and converted in US\$, it affords 195 MUS\$/year;

- *Hunting*: This estimate, roughly 35.9 MUS\$/year, includes both hunting and fishing activities. The estimates in Bann/Clemens (2001), quoted in Türker et al. (2002, 2005), are of the same order of magnitude: 17.8 MUS\$/year for hunting and 20.1 MUS\$/year for fishing, i.e. 37.9 MUS\$/year in total. Since the estimate from Pak et al. (2010) is of the same order of magnitude and more recent, this is the one that will be used;
- *Recreation*: The estimate, roughly 5.9 MUS\$/year, is three times less than the sole official revenue from national parks (33.4 MTL in 2012, i.e. 15.4 MUS\$/year), 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, this is the one that will be used;

Table 8.8 Revised disaggregation of the TEV for Turkish forests, according to the above data sources and calculation methods

TEV components (US \$) per year	Type of outputs	Value	Source	%
Direct use values	Wood based forest products	1 165 178 097	Pak et al. (2010)	66.6
	NWFPs	195 359 161	OGM (2014)	11.2
	Grazing	225 000 000	Pak et al. (2010)	12.9
	Hunting	35 948 500	Pak et 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 values	Pharmaceuticals	112 500 000	Pak et al. (2010)	6.4
Nonuse values	Existence value (to converse biodiversity)	1 380 000	Pak et al. (2010)	0.1
Positive TEV components 1 750 739 640				
Negative externalities	Erosion	-125 000 000	Pak et al. (2010)	94
	Forest fires	-8 607 537	Pak et al. (2010)	6
Negative TEV components		-133 607 537		
Net total TEV of forests (excl. C. storage) in US \$/year		1 617 132 103		
Average area of productive forest in 2010–2013 in ha		11 374 414		
Net total TEV of forests (excl. C. storage) in US \$/year/ha		142		

Source The authors

- *Carbon storage*: This value has been reviewed according to the IPCC (2013b) inventory guidelines and Kyoto accounting rules;
- *Other values and costs*: This category includes activities such as grazing and pharmaceutical values, as well as the erosion and forest fire costs, which are the same as in Pak et al. (2010), and Bann/Clemens (2001), quoted in Türker et al. (2001, 2005). Given the lack of other sources of data for these elements, we use these estimates.

Table 8.8 presents a revised disaggregation of the TEV for Turkish forests, according to the above data sources and calculation methods.

After reviewing the different non-carbon values (wood and non-wood products, grazing, hunting, recreation, pharmaceuticals use) and costs (erosion, forest fires) forming the TEV of the Turkish forest, the revised TEV can be estimated at 142 US \$/ha/year.

8.6 Conclusions

Overall, impressive improvements concerning the Turkish forests can be observed over the past decades, namely in the massive efforts in terms of rehabilitation of degraded forests and afforestation, conversion of coppices to high forests and in the technology attained to combat fire events and forest health. These measures have resulted in the increase of the forest biomass stocks, allowing for an increase of felling since the 2000s.

Finally, a complete assessment of carbon and non-carbon costs and benefits of implementing the LULUCF rules was conducted, for four different 3.4 FM scenarios (extensive versus intensive harvest, projected versus non-projected REL) and one single 3.3 A/R scenario, with the results shown in Table 8.9.

All the costs are assumed to be constant across all scenarios. The sensitivity of the estimated benefits to different carbon price assumption was calculated:

- 4 US\$/tCO₂eq: This is the lowest value observed, and it occurred 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 and voluntary markets was 7 US\$, according to the Ecosystem Marketplace report from 2013;
- 52 US\$/tCO₂eq. A report commissioned by the French Prime Minister in 2008 estimated the ‘shadow price’ of carbon, i.e. the recommended carbon price from 2011 up to 2050, needed to achieve the EU target of a fourfold reduction in GHG emissions by 2050 (Quinet 2009). The estimated value (by linear interpolation) for 2013 is 52 US\$/tCO₂eq, as shown in Table 8.9.

As can be observed, considering the recent EU market price (Kyoto market) or the recent forest carbon price (Kyoto and voluntary markets), carbon benefits show

Table 8.9 Recap of costs and benefits estimates of LULUCF accounting for different scenarios

Scenario for 3.4 FM, depending on the level of harvest by 2020 (in Mm ³ /yr)	REL non projected*		REL projected	
	Ext. harvest 32.3 Sc NP-Ex	Int. harvest 36.3 Sc NP-int	Ext. harvest 32.3 Sc P-Ex	Int. harvest 36.3 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 for 3.3 AR (MUS \$)	2.708			
3.4 FM RMUs between 2013–2020 (Millions of RMUs)	52.8	52.8	46.5	0
C benefit for 3.4 FM (MUS \$)	26.4	26.4	232	0
3.3 ARD RMUs between 2013–2020 (Millions 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: forest management (MUS \$)	3221			
Transaction costs for GHG LULUCF inventory (MUS \$)	1			
Total	7.835	7.835	7.804	7.571

Source Bouyer (2014)

great reductions in all the scenarios, compared with other values included in the forest TEV.

Negotiations are still on-going regarding the precise status of Turkey in the UNFCCC, which would in turn determine whether Turkey has to make binding commitments (including on LULUCF). But whatever choices are made by Turkey in terms of LULUCF accounting (esp. on Article 3.4 FM) and whatever assumptions on future carbon prices are made, the carbon benefit remains positive but marginal compared with non-carbon benefits, which are substantial.

However, since most operating costs would have been disbursed in any case (apart from the transaction costs for upgrading the GHG LULUCF inventory, which is marginal at 1.2 MUS\$), the carbon benefits can be assumed to be ‘extra net-benefits’. Furthermore, contrary to many forest values, carbon benefits can materialize.

Last but not the least, it is worth considering the carbon shadow price. It is worth noting that the situation is quite different for the 3.4 FM areas, and especially for 3.3 ARD areas, where the carbon benefits are substantial. However, this price level is still far from attainable 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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