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Assessment of Land Use, Land Use Change and Forestry Sector Potential in Achieving Climate Change Mitigation Objectives in Armenia

BACKGROUND REPORT

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Assessment of Land Use, Land Use Change and Forestry Sector Potential in Achieving Climate Change Mitigation Objectives in Armenia

Background report

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The objective of this report is to reflect country's Land Use, Land Use Change and Forestry sector profile in the context of greenhouse gas emissions and removals trends. The report also addresses the policy and institutional framework, including data sources, monitoring, reporting and data verification system, management practices per land use categories, and identifies key factors/drivers for observed changes.

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Summary

The Republic of Armenia ratified the UN Framework Convention on Climate Change (UNFCCC) in May 1993 as a developing country not included in Annex I to the Convention.

Armenia already submitted its first NDC the 22 September 2015 (Republic of Armenia, Government, 2015b), with the objective to keep an average emission of 5,4 tCO_{2eqv} per capita for the period 2015-2050, with an aggregate budget of 633 $MtCO_{2eqv}$ for this period; and its last Biennial Update Report in 2018.

According to the last GHG inventory report (Republic of Armenia, 2020a), the country total CO_{2eqv} emissions (excluding LULUCF) amounted to 10 624 Gg CO_{2eqv} in 2017, while the LULUCF sector represented a net sink of -444 Gg CO_{2eqv} in 2017. Therefore, the LULUCF sector allowed in 2017 to offset 4% of the emissions of the other sectors. In the context of the global objective of climate neutrality, reducing emissions but also increasing the LULUCF sink capacity is of crucial importance.

This project aims at identifying the major and best policies regarding LULUCF in order to respect its objectives.

Armenia is a landlocked country located in the Caucasus region. The territory is composed mainly by highlands and mountains separating narrow valleys. The steppes, located in the middle-mountainous belt on unforested dry areas with fertile soil cover, represent three quarter of the Armenian landscape. The **forests** of Armenia have suffered from severe degradation during the recent history due to the political and socio-economic situation in the country. Agriculture is one of the key sectors of the economy of Armenia, the main types of agricultural production in Armenia comprise grain and potatoes, vegetables, vegetable crops, grapes, fruit and berries, meat, milk, egg.

The first key stone for LULUCF assessment is the land use monitoring. Currently, in Armenia, there is a lack of institutional arrangements for the monitoring of land-use, and for the production of robust maps and datasets about land-use and land-use change. Yet some recent publication give interesting data for consistent land use monitoring.

Usually LULUCF is dominated by forest issues insofar as forests are the lands with higher stocks of carbon. It thus essential to monitor efficiently these lands. There is a lack of data to estimate precisely forest growth and the actual wood harvest. For this issues also, recent work may help to improve the quality of data used in the inventory and projections.

Afforestation and reforestation are one aim of the country in its climate pledges, afforestation and reforestation will be key actions to consider. Restauration and conservation of agricultural soils are other major challenges.

Introduction

General context

The Government of Armenia is currently supported by the EU4Climate Programme, to take actions against climate change. This support, funded by the European Union, is implemented by the United Nations Development Programme (UNDP).

Among all sectors involved in limiting climate change and developing resilience, the Land Use, Land Use change and Forestry (LULUCF) sector and the agriculture sector have a central role to play. As stated in the Paris Agreement, these sectors' contribution is essential to reach the long-term climate mitigation and adaptation objectives, especially to achieve carbon neutrality.

In the EU, a new regulation (2018/841) now ensure that accounted emissions from land use are entirely compensated by an equivalent removal of CO_2 from the atmosphere through action in the sector ("no debit" rule).

Aim of the assignment

Citepa and ONFi have been selected to conduct the mission for the assessment of Land Use, Land Use Change and Forestry Sector Potential in Achieving Climate Change Mitigation Objectives in Armenia. The overall objective of this assignment is to assess the potential for enhancing removals by sinks and reducing GHG anthropogenic emissions by sources in the LULUCF sector. Once this detailed analysis of the current situation is drawn, recommendations on policies and measures feasible from economic, social and environmental point of view will be developed.

5 deliverables are to be produced in this context:

- A background report
- A technical report
- A Policy note
- A workshop
- A final package of recommendations and guidance

Aim of the Background report

The present document is the first deliverable of the assignment.

It considers feedback and comments from UNDP Armenia.

1. Overview of the national circumstances

1.1 Land Use and Land Cover

1.1.1 Geography

1.Armenia is a landlocked country located in the Caucasus region bordered by Azerbaijan to the east and southwest, Georgia to the north, Iran to the south and Turkey to the west.

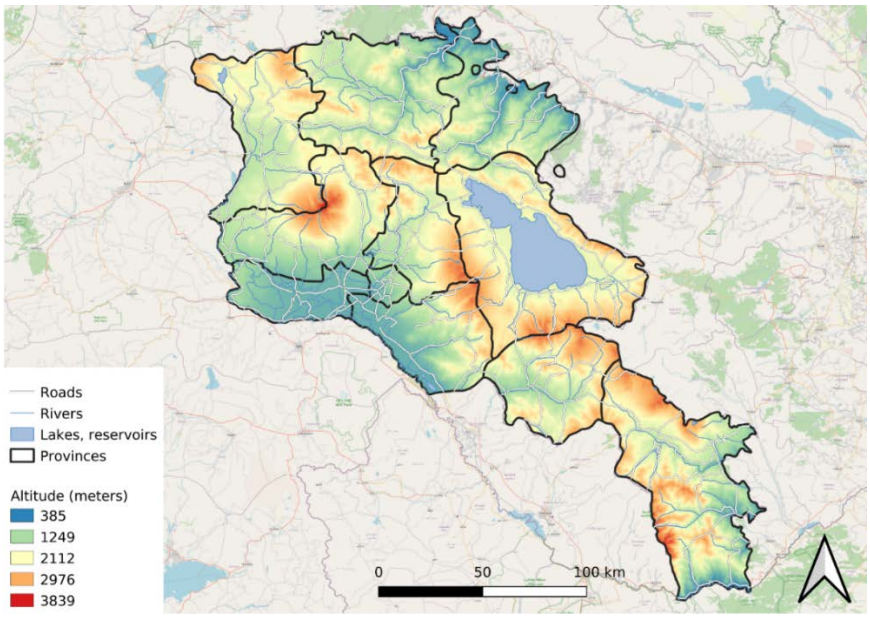
2. The country has an area of 29,800 29,743 km2 divided into 10 provinces and Yerevan, the capital city. The population of Armenia was 2 986 100 thousand persons in 2016 with a share of urban and rural population of 63.7% and 36.3%, respectively (ArmStat, 2017)

3.The territory is composed mainly by highlands and mountains separating narrow valleys. Around 90% of Armenia's land area is above 1000 meters above sea level, including 40% above of 2000 meters, with an average altitude of 1,850 meters and highest altitude of 4090m-Mount Aragats (UNDP, 2020).

4. The steppes, located in the middle-mountainous belt on unforested dry areas with fertile soil cover, represent three quarter of the Armenian landscape. Majority of endemic flora and animals of Armenia are living in this ecosystem (World Bank, 2012).

5. Hydrologically, Armenia is characterized by the Lake Sevan, the highest fresh-water lake in the world. The rivers belong to the Araks (76.4% of the territory) and the Kur (23.6%) river basins. There are 380 rivers with more than 10 km length in the country. The main sources of water in the rivers are snow and rainwater, which constitute an average of 54%, and for individual rivers (Aghstev, Pambak), they reach 65– 70%. For the rivers located in volcanic areas, underground supply plays a significant role (Baghdasaryan, 1981)[1].

Figure 1: Overview of the geography of Armenia



[1] *Baghdasaryan, A.B. 1981. Гидрография Армянской ССР (Hydrography of Armenian SSR). AS ASSR Publication, Yerevan, p.179*

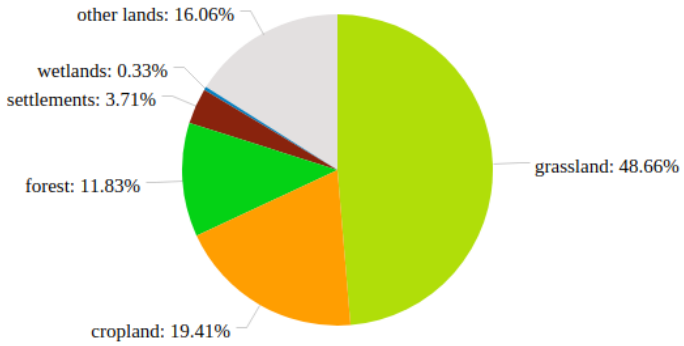
1.1.2 Current land use allocation

6. According to the last national land use classification (Republic of Armenia, 2020a), revised in 2017 for harmonization with 2006 IPCC guidelines (IPCC 2006), the territory of Armenia is allocated between:

- 1 435 624 ha of grassland including mainly hay-land and pasture lands;
- 572 550 ha of cropland including arable lands, perennial plants areas and a part of home garden;
- 349 000 ha of forest Land including all forest covered areas, ;
- 109 485 ha of settlements including lands for housing construction, lands without vegetation, infrastructure lands, and lands intended for healthcare, recreation and cultural and historical significance;
- 9 853 ha of wetlands including peat lands and lakes and waters reservoirs
- 473 745 ha of other lands that include unmanaged reserve lands, bare soil, rock, ice, and lands without vegetation.

7. The figure 2 summarizes the distribution of land use allocation in Armenia in 2017.

Figure 2: Distribution of Land use and land cover in Armenia in 2017



8. Grassland is the main land cover of Armenia followed by Cropland, other lands and forestland respectively.

1.1.3 Spatial allocation and historical land use changes

1.1.3.1 Available datasets

9. For national communication in latest GHG inventory (Republic of Armenia, 2020a), land use changes are based on land balances provided by the Real Estate Committee of the RA Government. It seems that RA does not have a satisfactory land use monitoring system. As consequence, investigation was led to identify sources of data providing additional information on spatial allocation of land use and land use changes.

10. Few scientific documentations exist on land use and land use change in Armenia and the majority of related scientific papers are mainly focusing on a specific land use and/or a specific region during one period.

11. Armenia report information under UNCCD Convention to combat desertification (UNCCD, 2018). This document presents land use time series and a land use matrix.

Table 1: Land use time series (UNCCD, 2018)

km2	Tree covered areas	Grassland	Cropland	Wetland	Artificial areas	Other Land
2006	4 192,59	14 266,28	6 101,54	249,80	2 402,81	1 010,96
2007	4 169,86	14 259,57	6 116,87	248,65	2 415,31	1 010,96
2008	4 166,72	14 451,52	6 117,48	242,61	2 432,07	1 010,96
2009	4 166,88	14 249,98	6 117,67	235,55	2 440,32	1 010,96
2010	4 162,54	14 268,09	6 109,21	224,85	2 467,61	1 010,96
2011	4 073,13	14 287,03	6 198,47	191,55	2 487,89	1 010,96
2012	4 000,63	14 456,27	6 146,75	151,04	2 483,29	1 010,96
2013	4 002,25	14 483,58	6 145,53	107,13	2 499,67	1 010,96
2014	4 002,31	14 491,48	6 141,52	88,59	2 514,24	1 010,96
2015	4 000,76	14 499,86	6 134,18	86,20	2 517,14	1 010,96

Table 2: Land use change matrix (UNCCD, 2018)

km2	Tree covered areas	Grassland	Cropland	Wetland	Artificial areas	Other Land
Tree covered areas	3 941,56	175,96	10,52		64,60	
Grassland	56,90	14 127,05	32,60		49,73	
Cropland	2,29	8,20	6 091,10			
Wetland		163,60		86,20		
Artificial areas					2 402,81	
Other Land						1 011,00

12.The most comprehensive dataset found for spatially assess land use change over the country and during the last decades comes from Buchner et al. (2020). This publication is based on Landsat remote sensing data. Landsat 8 provides images for more recent years with a resolution of 30m, it remains rather coarse compared to current SPOT5 images which can have a resolution of 2.5m but considering the objective to elaborate consistent time series since 1987, it is assumed to be relevant. The images for 1987 had a similar resolution (landsat5 had also a resolution of 30m). The main expected effect of this "low" resolution is the difficulty to track small areas of changes and the possibility to underestimate actual changes. On the other hand it limits the risk of overestimating changes due to unavoidable noise in high resolution images. The authors mapped land use and land cover for 2015 and additionally the gains and losses of croplands and forests across the Caucasus Mountains from 1987 to 2015.

13. However, the land use classification does not perfectly match with national land use classification. The data are therefore only used to provide more information on spatial land use allocation and trends in Armenia and is not intended to call into question the official classification which remains the reference.

14. Table 1 provides a comparison of land use allocation of both sources of data after harmonizing the classification of map[2].

Table 3: Comparison of land use allocation between national data and Buchner and al. (2020)

	LULUC 2017 (ha) from National GHG Inventory	LULUC 2015 from Buchner et al. (2020)
grassland	1 435 624	1 950 872
cropland	572 550	501 175
forest land	349 000	363 367
settlements	109 485	6 240
wetlands	9 853	16 405
other lands	473 745	130 850

15. Globally, the distribution is converging between both data sources in terms of land use distribution. The main gap comes from 'grassland' and 'other lands' allocations suggesting a confusion between the two classifications in spatial dataset. Particularly, in spatial dataset 'other land' class includes only 'water', 'ice and snow' while wider definition of other land is used in the national classification (including bare soil, without vegetation cover areas, etc.).

16. Keeping this uncertainty in mind, the spatial data provides anyway additional information on spatial allocation of land use and land use change in Armenia from 1987 to 2015.

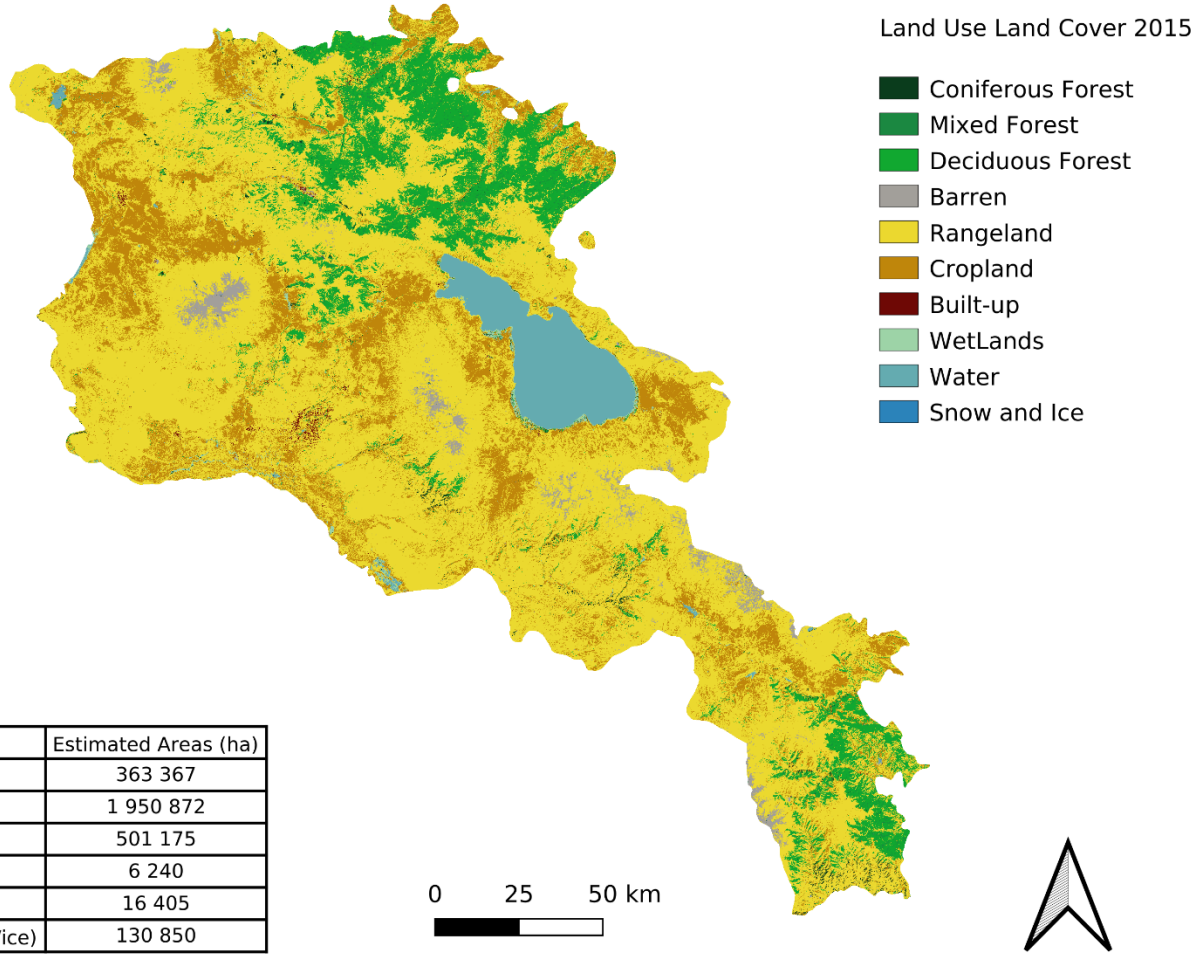
1.1.3.2 Spatial allocation of land use in 2015

17. Figure 3 illustrates the domination of Grassland over the country in 2015 while cropland appears unevenly distributed over the country even if particularly present from North-West and Central part of the country.

18. Preserved forest lands are mainly located in the North-East and South-East of the country. Small, disturbed forest patches are present in central part of Armenia.

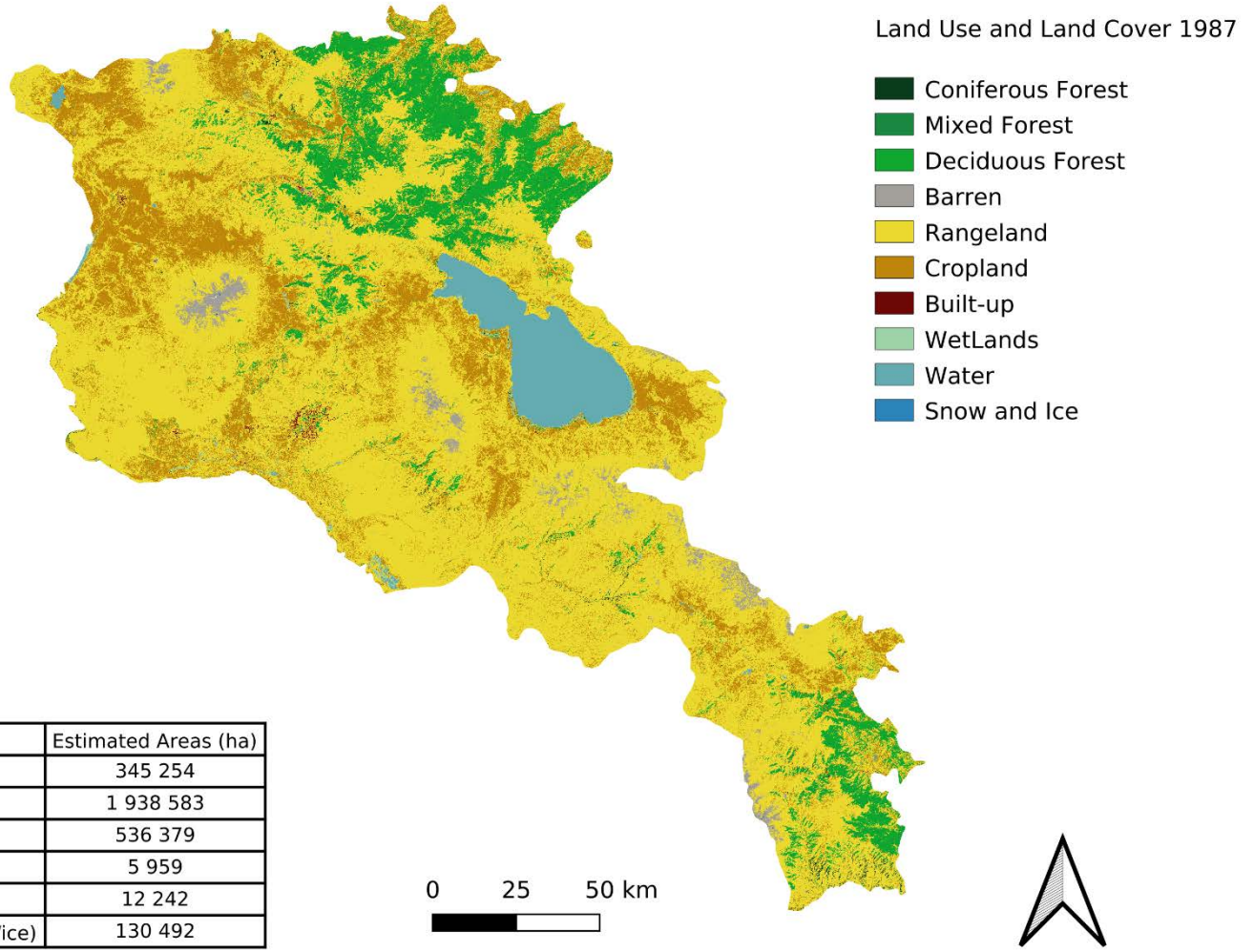
[2] In the spatial dataset, 'coniferous', 'deciduous' and 'mixed forest' were merged into 'forest' class while rangeland and 'barren land' were merge into 'grassland'.

Figure 3: Land Use and Land Cover of Armenia in 2015 according to data of Buchner et al. (2020)



Revised Classification	Estimated Areas (ha)
Forest	363 367
Grassland	1 950 872
Cropland	501 175
Built-up	6 240
Wetlands	16 405
others lands (Water/snow/ice)	130 850

Figure 4: Land Use and Land Cover of Armenia in 1987 adapted from Buchner and al. (2020)



Revised Classification	Estimated Areas (ha)
Forest	345 254
Grassland	1 938 583
Cropland	536 379
Built-up	5 959
Wetlands	12 242
others lands (Water/snow/ice)	130 492

1.1.3.3 Land use change in Armenia from 1987 to 2015

19. Based on land cover and land use map of 2015 and forest and Cropland Gains-losses maps since 1987, the land cover land use map of 1987 has been computed. This map is illustrated in Figure 4.

20. Comparison of LULC maps of 1987 and 2015 highlighted relative stability in spatial land use and land cover allocation in Armenia.

21. The main substantial effects that can be highlighted comes from i) an apparent reduction of cropland areas particularly in North-West of Armenia and ii) a marginal increase of forest land in North-East of the country, while grassland areas are relatively stable since 1987. These changes were confirmed and specified by national expert judgement [3]: "Reduction of cropland for 1987-2015 took place through whole Armenia. It is related to massive reduction of agricultural state subsidies to farmers, mass and non-efficient privatization of lands and destroyed infrastructures. First forest cover decreased (for 1992-2005), then increased (2006 and onward) thanks to natural regeneration of illegally logged and degraded forest stands in 1990s and early 2000s. Unfortunately the increase of forest area is performed mostly by non-valuable tree species and bushes".

22. The following table summarizes the land use and land cover areas from 1987 to 2015.

Table 4: Cross-comparison of land use between 1987 and 2015 using spatial data of Buchner et al. (2020)

(hectares)	LULC 2015 from Buchner et al. (2020)	LULC 1987 from Authors using data of Buchner et al. (2020)	Estimates of Land Use change from 1987 to 2015 from Authors using data of Buchner et al. (2020)	Rate of change
grassland	1 950 872	1 938 583	12 289	1%
cropland	501 175	536 379	-35 204	-7%
forest land	363 367	345 254	18 113	5%
settlements	6 240	5 959	281	5%
wetlands	16 405	12 242	4 163	34%
other lands	130 850	130 492	358	0%

[3] Hovik Sayadyan, February 2021

2. Assessment of forestry and agricultural management practices

2.1 Forestry

2.1.1 Current situation and issues

23. The **forests** of Armenia have suffered from severe degradation during the recent history due to the political and socio-economic situation in the country.

24. Officially, in 2020, forests cover 11.2% of Armenia's territory, i.e. more than 328,470 hectares (FAO, 2020a), characterized by significant geographical disparities. In fact, a large majority (62%) of the forest areas are in the north-eastern part of the country against 36% in the south-east and 2% in the central part.

25. The Armenian forest is composed of 274 species of trees and bushes, however, the forests are largely dominated by oak, hornbeam, pine and beech species. Rare tree species were considerably damaged and degraded due to un-controlled and un-efficient logging operations and are only scattered in some forest patches (Republic Of Armenia, 2009).

26. Armenia has seen more than half of its natural forests reduced before, during the last centuries, mainly due to anthropogenic factors but also to continuous aridification (Sayadyan, 2006). As a result, easily accessible forest areas are gone, and remaining forest areas are hardly accessible and inappropriate to develop any forestry activities. This explains a logical reduction in the rate of forest degradation, since less areas are available for degradation (Republic of Armenia, 2005). There are also thousands of hectares of coppice regenerated in very dense stands (in the place of mass illegal loggings) that are inaccessible (even for wild animals) and very risky regarding forest fires[4].

27. At the time of the last national inventory in 1993, forest cover was estimated at 334,000 hectares divided between 321,000 hectares of natural forest and 14,000 hectares of planted forest representing a total standing forest volume of about 42 million m3 with an annual average growth of 0.45 million m3 (Moreno-Sanchez, 2005, World Bank, 2020).

28. According to the FAO (2020), forest cover is now estimated at 310,000 hectares and 18,000 hectares of natural and planted forest respectively. These estimates show a net decrease of 6,000 hectares of forest cover over the last 18 years.

29. According to Republic of Armenia (2020b), the areas allocated to reforestation and afforestation activities were respectively 2,150 hectares during the period 1998-2006, then 2,754 hectares during the period 2006-2012 and 3,303 hectares during the period 2013-2018. It can be noted that these reforestation areas are much lower than what was observed in the 1970s were between 2000 ha and 4000 ha were forested annually[5].

[4] National expert Judgement: Hovik Sayadyan

[5] Kazaryan V.O., Harutyunyan L.V, Khurshudyan P.A., Grigoryan V.G., Barseghyan A.M. The scientific bases for aforestation and greening of Armenian SSR, Yerevan, National Academy of Armenia publication, 1971,-p,334.

30. Armenia does not have a national forest monitoring system based on remote sensing and, therefore, all estimates of forest condition over the years are based on the last national inventory of 1993 and the annual flow of marketed timber (Republic of Armenia, 2020a). This lack of up-to-date data and, in particular, the absence of spatial mapping to monitor forest cover limits knowledge and understanding of spatial disturbance of forests over time.

2.1.2 Forest Uses and Economy

2.1.2.1 Wood production and consumption

31. **Industrial and commercial logging** is prohibited in Armenia, and the government does not issue licenses for commercial timber harvesting. In addition, the composition and configuration of forest resources in Armenia limit the potential for commercial logging. There are no forest plantations for productive purposes in Armenia and natural forests are too small, relatively unusable for industrial purposes and the most valuable tree species are now too rare (Khechoyan, 2018, Khurshudyan, 1999a & 1999b).

32. The only authorized harvest is due to **sanitary felling** to prevent the spread of pests and diseases, or regular thinning for the maintenance of protected forests. From 2015 to 2018, the State Non-Commercial Organization (SNCO) "Hayantar" has authorized sanitary felling for 25,000 to 35,000m3 per year. Only 10% of these are for building materials, all the rest are mainly used for fuelwood supply.

33. Due to the lack of availability of domestic raw material, the wood processing industry (including primary and secondary wood processing) is poorly developed. The wood industry is highly fragmented, with small enterprises highlighting a relatively unproductive and unprofitable activity in Armenia facing international competition (World Bank, 2020) (Economy and values research center, 2007).

34.The main **demand for wood** comes from the consumption of firewood. The high demand is driven by the high price of alternative fuels, especially gas, in rural areas. In addition, a substantial additional demand for wood comes from the charcoal consumption of Armenian restaurants, most of which use a traditional wood-fired grilling method.

35. Several sources can satisfy the need for firewood:

- **annual allowable cuts (AAC)**, which are tickets to cut wood; set by the Government in the framework of the Forest Management Plans (FMP) developed by the Forest Research Experimental Center and local organizations. The AAC is set intentionally low that it could be considering the annual growth, because other parameters are considered: the area of forest that is accessible (63%), the aim to let some forest areas to recover, etc. (Junge & Fripp, 2011). Sanitary cutting are included in the AAC;
- **debris from sanitary felling** (performed by Hayantar) according to decree #1535-N (2011) each household in forest-dependent communities may collect and obtain up to 8m^3 of these debris wood per year for firewood purposes for free from the regional forestry organization (under Hayantar) (Perge, et al. 2020). The rest can be sold (Junge & Fripp, 2011);

- **fallen woods** (dead woods and branches naturally fallen – as windfalls and snowbreaks are very common)[6];
- **thinning and deadwood from non-forest trees** (orchards, agricultural zones, hedges…);
- **wood and wood substitutes imported** from other countries**;**
- **wood from illegal cuts** sold at the black market.

36. Due to the lack of domestic wood production, Armenia is a net importer of wood products. However, international trade in wood products is weakly developed in Armenia[7] with regard to the importance of the informal sector of the wood industry in the country and the cost of imported products (Perge, et al. 2020).

37.The supply from AAC, sanitary felling and imported wood is not sufficient (or too expensive) to meet the demand, leaving poor rural families with no alternative to unregistered/illegal removal of firewood (Mkrtchyan, 2014). The gap between supply and demand is informally filled by the black market and illegal logging, which are considered to be the main channels of timber supply in Armenia (Economy and values research center, 2007).

38. There is a lack of data to precisely estimate the actual fuelwood supply in the country, and different estimations are not always consistent. Using available estimations available in the literature, one must consider the following distinctions:

- theoretical demand and effective demand for fuelwood;
- fuelwood supply from forest and from non-forest;
- Wood legally obtained from annual allowable cuts, wood legally obtained from debris of sanitary felling, wood obtained from illegal cuts, wood obtained from imports;
- Recorded estimates (i.e. quantified, both legal and illegal); and unrecorded estimates (i.e. non quantified).

39.Considering these distinctions, the following estimates are available:

- The more recent publication (UNDP-GEF, 2020) indicated that the maximum of permitted logging (AAC) in the post-Soviet period reached 202,000 m3, then it began to steadily decline and in recent years does not exceed 35,000 m3. At the same time, the officially reported actual harvesting is significantly less. The maximum logging comprised 95,000 m3 in 2014 after that it began to decline, reaching a minimum of 23,000 m3 in 2016.
- According to Pasoyan & Sakanyan (2019) Energy demand, supply and efficiency in rural Armenia: baseline data collection and analysis. GIZ, 58p. , the estimated annual demand (supposedly the *effective* demand) for fuelwood was about 842,477 m^3 in 2017-18,, consistent with the value found in Perge et al. 2020 (848 000 m3 for 2016), of which 99% was from licensed domestic use.

[6] Windfalls and snow breaks are very common and damage large-areas in forest.
[7] According to the World Bank Statistics, Armenia exported 3 522 US$ Thousand and imported 210 677 US$ Thousand in 2018. Source of data available at: https://wits.worldbank.org/CountryProfile/en/Country/ARM/Year/2018/TradeFlow/Import/Partner/BY-COUNTRY/Product/44-49_Wood#

- According to data from the UN Energy Statistics database[8], used by the World Bank analysis (World Bank, 2020), fuelwood production is estimated for each year for the period 1992-2017 (table X below). For 2016 and 2017, the annual production is estimated at 678 000 m^3 and 666 000 m^3. However, in the World Bank analysis, the value indicated for 2016 is 848 000 m^3, precising that "officially recorded supply equals AAC + fallen wood, illegal production and imports".

Year	production (1000 m3)	import (1000 m3)
1992	0	nd
1993	0	nd
1994	0	nd
1995	0	nd
1996	0	nd
1997	62	nd
1998	0	nd
1999	0	nd
2000	57	nd
2001	42	nd
2002	46	nd
2003	56	nd
2004	59	nd
2005	39	nd
2006	63	nd
2007	40	nd
2008	1 368	nd
2009	15	nd
2010	175	nd
2011	2 074	nd
2012	2 074	0
2013	1 546	0
2014	1 782	0
2015	557	0
2016	678	0
2017	666	0

- According to the Sixth National Report to the Convention on Biological Diversity, used by the Perge et al. (2020), from 2014 to 1st October 1998, 10 606 m3 of timber and 116 980 m3 of fuelwood was sold out of the total harvested volume;
- According to the Sixth National Report to the Convention on Biological Diversity, used by the Perge et al. (2020), in 2017, 66 614 m^3 of debris fuelwood (a part of the total debris wood) was provided for free to the people living close to the forest areas.
- According to Junge & Fripp (2011), the official recorded supply of fuelwood was estimated, for 2010, at 75 000 m3; while the consumption was estimated at 457 000m3 (ICARE, 2011) "but could be multiple of that".

[8] Link to the UN Data page filtered on Fuelwood statistics for Armenia

- According to Hayantar SNCO, cited by Junge & Fripp (2011), fallen wood could be as much as 1 m3/ha of forest cover.
- The national average consumption of fuelwood was estimated at 6,8m^3/y per household but this value hides a wide discrepancy between households. In rural mountainous households, the consumption of fuelwood was estimated at 15m^3/y per household (Fripp, 2010, cited by Perge et al, 2020).
- Perge et al. (2020) also refer to an estimate of a "total cutting area" (supposedly legal cuts of AAC) of 1 558 ha in 2014, 1 501 ha in 2015, 1 940 ha in 2016 and 2 010 ha in 2017.
- According to several authors, illegal logging is estimated to be 20 to 30 times higher than official data (World Bank, 2020) showing total removals of 535 000 m^3 in 2015 (FAO, UNECE, 2019).
- The World Bank (2020) has proposed the following recap of forestry key values in Armenia:

	Armenia
Forest cover, official estimate	11.2%
Annual increment, million m^3	0.45*
Harvesting, official, million m^3	0.04 (2018)
Wood use, informal estimate, million m^3	0.8
Legal commercial harvesting	no
Reforestation area, ha	423 (2017)
Wood product exports (US$ million)	negligible

* outdated information, likely notably lower

- Annual firewood consumption by restaurants is estimated between 100,000 and 140,000 m^3 (World Bank, 2020)
- As cited by Pasoyan & Sakanyan (2019), according to RECS estimate (RECS, 2015), about 2 mln c.m wood was used for heating by HHs in Armenia (2014-2015), of which 1,5 mln c.m. in villages, 0,07 mln c.m. in Yerevan and 0,5 mln c.m. in other cities.
- As cited by Pasoyan & Sakanyan (2019), Annual allowable cut by "Hayantar" SNCO in 2014 was 29,023 c.m., in 2015 – 25,977c.m., in 2016 – 25,641 c.m. and in 2017 – 29,926.5 c.m.(with about 10% of construction wood)[9] . Meanwhile, in the mentioned period the surface of logging areas has been increasing: 1558 ha in 2014, 1501 ha in 2015, 1940 ha in 2016 and 2010 ha in 2017.
- Pasoyan & Sakanyan (2019) consider that that the fuelwood demand significantly (at least 20 times) exceeds the fuelwood supply, persistently leaving damaging impacts on forests, harvesting beyond the natural recovery rate. Overexploitation of forests from illegal logging has caused numerous environmental problems, including soil water imbalance, erosion on mountain slopes, and landslides. High oak and beech forests have been replaced by coppice woodlands and are not being restored at all in some locations. Harvesting of high-productive forests of even by selective felling leads to their replacement with low-productivity stands with reduced regenerative capacity and, consequently, low ecological sustainability (UNDP-GEF, 2020).

40. In this context, the failures of the wood market in Armenia and the associated unregulated logging have a great impact on the self-healing capacities of forests and contribute to their degradation. Wood consumption in Armenia mainly from the black market and illegal logging for fuelwood consumption is higher than the growth rate of the forests, leading to a progressive loss of forest stock in accessible zones (Economy and values research center, 2007).

2.1.2.2 Forest land uses

41. Grazing lands are not clearly regulated in Armenia, forests adjacent to local communities are being damaged by overgrazing of livestock, both large and small, due to lack of fodder and inaccessibility of pastures and hayfields. In particular, the use of the forest for shelter and fodder for grazing livestock damages natural regrowth and seedlings (Khechoyan, 2018 ; Maghakyan, 1941 ; World bank, 2002). Consequently, grazing of large and small livestock in forests also contributes to forest degradation. By destroying the natural regrowth, the forest is deprived of the young trees and if there is continuous grazing, degradation occurs.

42. The open mining industry contributes to the conversion of forest land in Armenia. Thousands of hectares of the state's territory are now occupied by mines industry (World Bank, 2016). Land for industry, bowel utilization and other production has increased by about 30% in the last ten years, from 29,360 ha in 2009 to 38,400 ha in 2018[9]. Open mining in forest areas is of particular concern, as shown by the well-known example of the opening of a copper-molybdenum mine in Teghut. Before the mine was exploited, the forest near Teghut was one of the most preserved in Armenia, with a rich biodiversity. If there are operating mines in lot of regions, mainly are concentrated in the Lori and Syunik province.

43. Other forest uses in Armenia include non-timber forest products (NTFP) by communities such as hay, forest fruits, honey, mushrooms, medicinal plants and recreation (Sayadyan, 2011 ; Mkrtchyan, 2016). NTFPs are important sources of food and fodder as well as income for local families (FAO, 2019). However, these activities are poorly documented without relevant data being available, resulting in a lack of estimation of the true importance of NTFP uses.

2.1.2.3 Natural disturbances

44.Climate change is creating favorable conditions for the massive spread of forest **pests and diseases** in Armenia (Hertel et al., 2004). According to official documents, the number of areas infected by forest diseases has increased in the country since 2000 (Republic of Armenia, 2009). SNCO's Hayantar companies regularly carry out preventive and remedial logging to combat the spread of pests and diseases. However no recent data exists in the literature on that and forest disturbances by diseases are not reported in Forest Resources Assessment of Armenia (FAO, 2020a).

45. **Forest fires** mainly caused by human negligence have as well a negative impact on the degradation of forest areas in Armenia. Forest fires are exacerbated by climate change,

[9] More information at: https://ampop.am/en/mineral-industry-of-armenia/ last consulted on 12/31/2020

although in recent years, thanks to preventive measures taken in Armenia, the damage caused by man-made forest fires has decreased (Khechoyan 2018).

46. However, little data on forest fires is available and existing data sources are not convergent. For example, according to Khechoyan (2018), in 1998-2010, 198 fires were recorded that burned approximately 1700 hectares of forest. Over the period 2011-2015, according to the same author, the loss of forest area reached 500 hectares (or an average of 100 hectares per year) while 895 hectares of burnt area were reported in the last national GHG inventory in 2017 against 64 and 28 hectares in 2013 and 2014 respectively, according to the estimate of the national GHG inventory of 2014. Additionnal forest fires data is also registered by the Ministry of Emergency Situations and Hayantar, but could not be accessed for this report. It can also be reminded that windfalls are also big threat to Armenian forests : due to the fact that on upper timber line forest stands are damaged by non-regulated loggings and became park forests with sparse trees prone to winds and avalanches.

2.2 Agricultural lands

2.2.1 Current situation and issues

47. Agriculture is one of the key sectors of the economy of Armenia, contributing around 15-16% of GDP in recent years. In 2016, 42.8% of Armenia's gross agricultural product is attributable to animal farming. The main types of agricultural production in Armenia comprise grain and potatoes, vegetables, vegetable crops, grapes, fruit and berries, meat, milk, egg (Republic of Armenia, 2020b).

48. The total area of Armenia's agricultural land covers 2,043.8 thousand hectares, including: arable land - 446.0 thousand hectares (21.8%), perennial plantations - 34.8 thousand hectares (1.7%), grassland - 121.0 thousand hectares (5.9%), pastures - 1,050.8 thousand hectares (51.4%) and other lands - 391.2 thousand hectares (19.2%) (Republic of Armenia, 2020b).

49. The current agriculture situation is characterized by the land property structure inherited from the post-soviet agrarian reforms that started in March 1991. Formerly collectivized agriculture areas were privatized (except pastures and haylands) and land was allocated in fixed units calculated by dividing the total available land in the village by the total population. As a result there are many small farms of smallholders (around 340 000 farms, 1.2 million of small plots). In the 2000's, only 12,3% of individual farms use more than 2 ha per farm (Lerman, 2006). Today, each farm on average have 1.4 hectares of agricultural parcel, including 1.1 hectares of arable land (Republic of Armenia, 2020b).

50. Land management is one of the issues of the country's agricultural policy. There are major challenges for implementing complex and coordinated agro-technical activities and addressing environmental problems. The current situation requires appropriate steps to be taken to enable the use of modern, effective land use technologies, along with contributing to the reduction of GHG emissions (Republic of Armenia, 2020b). Increasing the efficiency of land use is one of the most important issues in the agriculture sector. It has been stipulated in the Sustainable Agriculture Development Strategy of RA (2015-2025). The strategy envisages to include at least 10 thousand hectares of unused arable land in crop rotation per annum. As of 2017, the area of unused arable land in the country comprises over 200,000 hectares (Republic of Armenia, 2020b).

51. In 1998, 80% of individual farms were selling a part of their production (40% of their total output) – the sellers have the larger holdings (2,3ha mean in 2003 vs 1,4ha for non-sellers) and the greater number of animals (2,2 heads for sellers in 2003, vs 1 for non-sellers). Gross agriculture output increased since 1993. (Lerman, 2006).

52. After being affected by economic crisis in 1991-1993, additionally to land privatization, the agricultural sector underwent structural changes. The area of irrigated land decreased 2-fold and the use of mineral fertilizers – 3-fold. (Republic of Armenia, 2020b).

Another issue is the land abandonment. It is estimated that one-third of agricultural land in Armenia is out of use (FAO,2020b). This was general process in former USSR area (Yin, 2019).

53. Another issue for Armenia's agriculture is the water and wind erosion, and even desertification process. It is estimated that about 81 percent of Armenia's territory is exposed by desertification driven by both, natural and anthropogenic factors, such as inefficient agricultural practices, illegal logging, overuse of groundwater resources (artesian wells), mining, soil contamination… More than the half of all pastures and hayfields are degraded, caused both by over- and under-grazing (FAO,2020b ; GEF-WB, 2014). In 2015, the proportion of degraded lands comprised 1.67% (or 472.5 km^2) of total terrestrial land area (excluding inland reservoirs). Currently, a decrease in soil fertility, reduction in carbon stocks and activation of erosion processes is observed in all the natural zones of Armenia. This is explained by the influence of anthropogenic, as well as natural innate factors (Republic of Armenia, 2020b). Markosyan et al. (2013) showed that the magnitude of annual soil loss from erosion by mouldboard processing system in a mountain-steppe zone of the republic is from 1,5 to 24,0 t/ha or more. These processes occur more rapidly at low altitudes, where the irrigated meadow-brown soils are wide-spread (Ghazaryan & Kroyan, 2016 ; Rhoades, 2018).

2.2.2 Current practices

54. In the cropland areas, the traditional mouldboard ploughing is applied everywhere, regardless of the relief terrain, soil and climatic conditions, agricultural techniques, predecessors, etc, leading to soil erosion (Markosyan et al. 2013).

55. Armenia's irrigation system organisation needs improvement, to mitigate water deficit and soil degradation issues. Irrigation, prolonged and indiscriminate use of meadow-brown soils of the Ararat plain leads to the degradation and desertification (Ghazaryan & Kroyan, 2016).

56. Livestock breeding has resulted in the overgrazing of sub-alpine and alpine meadows, areas with important biodiversity and landscape values.

2.3 Wetlands

57. In Armenia, and more generally in the Caucasus, the wetlands have been the most heavily impacted by land transformation and degradation, mainly illegal logging, overgrazing, extensive fishery, pollution, and reclamation into agricultural and urban areas (Ramsar, 2008).

3. Institutions and policy

3.1 Institutional framework

3.1.1 Government and public agencies

3.1.1.1 Land use monitoring

58. There is currently a lack of institutional arrangements for the monitoring of land-use, and for the production of robust maps and datasets about land-use and land-use change in the Republic of Armenia.

59. The official source for monitoring land-use change data used for the LULUCF inventory is regional statistics, collected annually by each Marz administration. The Marz administrations are sending information to national statistics and the land property rights are registered by Cadastre.

60. Other non-governmental sources of information for land-use monitoring can be found in international land-use and land-cover datasets (such as GlobCover, Global Land Cover, ESA-CCI Land Cover, MODIS…) and in the scientific literature (Buchner et al. 2020), as used in the present report.

61. A robust land-use monitoring that allows to estimate land-use changes over at least the last 20 years is a critical step to improve the LULUCF inventory and to develop adequate scenarios for mitigation.

3.1.1.2 Forest governance

62. In the soviet period, all forests were state owned. In 1994, a new Armenian Forestry Code was published based on the 1978 Soviet Forestry Code, again declaring all forests as state owned and reserved for protection and conservation (Sayadyan & Moreno- Sanchez, 2006 ; Nilson, 1992). It was replaced by RA's new "Forest Code", adopted in 2005 (Republic of Armenia, 2005b). The forestry code has never been modified since then.

63. Today, almost all forest area is state property, and can either be state forests under the management of Hayantar SNCO, or be *Specially Protected Natural Areas* managed by Ministry of Nature Protection. Since 2018, Armenia's forests and forest lands are under the state management by the Ministry of Environment, previously, they were under the management of the Ministry of Agriculture. Private forests also exist (Perge et al. 2020) but they are small patches that have been developed on privatized lands. The main policy and environmental issues relate to state forests.

64. According to the Forest Code, forests of Armenia, regardless of their form of ownership, are classified into protective, special and productive forest types, depending on their designated purpose. The protective group of forests also includes the 200 m area spanning upper and lower boundaries of the forest, as well as forests growing in semi-desert, steppe and forest steppe zones.

65.The State Forest Committee, established by the President's Decree NH-922-A (dated December 19, 2017), aims at provision of sustainable forest management, including conservation, protection, restoration, afforestation and effective use of forests.

66. Forest governance also includes institutional control and law enforcement bodies such as the "State Environmental Inspectorate" (SEI), responsible for monitoring legal limits on forest use and the "National Forest Monitoring Centre" (SFMC) (Nils et al., 2011).

67. As already revealed by several authors (Armen et al., 2010, Nils et al., 2011, FAO, 2019), the lack of clear and unified rules for the management of forests, especially sanctuary forests, and the limited differentiation of responsibilities between the different institutions and bodies involved in forest management can lead to confusion and inefficiency in operational forest management and protection activities.

State forest managed by Hayantar

68. 75% of the Armenian forest is managed by Hayantar. ''Hayantar" was created in 1988 as a Forestry Industrial Association, under the Ministry of Agriculture and then transferred in 1995 under the Ministry of Nature Protection and renamed as ''Hayantar" State Enterprise (Sayadyan & Moreno-Sanchez, 2006; Burns et al. 2017). The State Non-Commercial Organization (SNCO) "Hayantar" consists in delegating the management of state forests and sustainable use of forests to 19 forestry enterprises located in different regions of Armenia. According to the 2005 Forestry Code (Republic of Armenia, (2005b), these enterprises are subject to a Forest Management Plan (FMP) (Republic of Armenia, 2005). Hayantar is in charge of forest management, and wood supply from sanitary felling (including thinning).

69. The FMPs are supposed to govern the rational and sustainable use of forest resources for 10-year periods. The first MFPs developed during the period 2006-2008, some of which have not been renewed, have now expired, while a minority of companies have not FMP at all. As a result, the Armenian forest suffers from a lack of medium- and long-term planning and coordination, resulting in particular from the lack of ownership and implementation of MFPs (Armen, 2017).

Specially Protected Natural Areas managed by Ministry of Nature Protection

70. 25% of Armenian state forest is designated as *Specially Protected Natural Areas* (SPNA) and managed by the Ministry of Environment.

71.Under the Ministry of Environment, several departments are relevant for LULUCF policies definition and implementation: Climate Policy Department; Forest Policy Department; Department for specially protected areas of nature and biodiversity policy; Strategic Policy Department.

72. SNPAs include "state reserves," "national parks," and "sanctuaries," each characterized by a different level of restriction on human activities. The main objective of NAPS is therefore the long-term conservation and protection of strategic natural areas with high biodiversity value.

3.1.2 Other organisations

73. Among the national academic and scientific organisations, the Armenian National Agrarian University (in particular, the Chair of Forestry and Agri-Ecology[10], the Chair of Land Management and Land cadastre and the Scientific Centre of Soil Science) is relevant is the main scientific and research organization relevant for the LULUCF sector.

74. United Nations Development Programme (UNDP) Armenia supports the government in meeting its development priorities and the Sustainable Development Goals since 1993. The UNDP, through its Climate Change Program supports the Ministry of Environment, as an authorized national entity, in fulfilling the country's obligations under UNFCCC.

75. The FAO (Food and Agriculture Organization of the United Nations – of which Armenia is a member since 1993) produces datasets and develops programs relevant for the LULUCF sector in Armenia, in particular, through the FAO Representation Office in Armenia (founded in September 2004). Armenia has received FAO's support in implementing various development and emergency projects, aiming at increasing agricultural productivity and improving the country's food security. FAO and the government of Armenia have implemented the County Programme Framework (CPF) during the period 2016-2020 to increase the competitiveness of farmers, foresters and fisher folks and improve rural livelihood. The priority area #1 of this CPF is "Priority Area 1: Sustainable use of natural resources, disaster risk reduction and management"[11]. It aims to strengthen core systems, policy frameworks and capacities for the sustainable use of natural resources; to ensure that national authorities are better equipped to carry out informed policy making; and to contribute to improved resilience in responding to climate change, crises, and disasters. Among the projects developed by FAO Armenia[12], the following are particularly relevant:

- A project of technical support for revision of the National Forest Policy and Strategic framework is in place from March 2020 to March 2021;
- A project to achieve land degradation neutrality through restoration of degraded landscapes has been launched on June 2020[13];
- A project to create enabling environments for enhanced climate resilience in agriculture is in place from April 2020 to 2022;
- A project for the establishment of land management instruments and institutional framework to address land abandonment is in place from April 2019 to 2021;

76. The World Bank has produced several studies that are useful to understand the national circumstances of the agriculture and forestry sector in Armenia (World bank, 2020; Perge et al. 2020; Burns et al. 2017).

3.1.3 Overview of relevant organisations for mitigation actions

77. The table below presents a summary of the main organisations relevant for the definition, the implementation and the monitoring of LULUCF mitigation actions in Armenia.

[10] https://anau.am/en/en-english-chair-of-forestry-and-agri-ecology/
[11] http://www.fao.org/armenia/programmes-and-projects/en/
[12] See complete list: http://www.fao.org/armenia/programmes-and-projects/project-list/en/
[13] http://www.fao.org/armenia/news/detail-events/en/c/1293964/

Table 5: Overview of organizations relevant for mitigation actions in the LULUCF sector

Type of action	Entities relevant for implementation
Monitoring of land-use areas	Marz administrations, Cadastre Committee, MoE-department of land
Monitoring of forest	Hayantar, MoE, Cadaster Committee, State Forest Committee
Forest management and protection in national parks	MoE, State Forest Committee
Forest management in state forests	Hayantar, State Forest Committee
Monitoring of illegal cuttings	Hayantar, SEI (State Inspectorate), Forest Monitoring Center
Diffusion of agroecology practices	FAO Armenia, Agrarian University

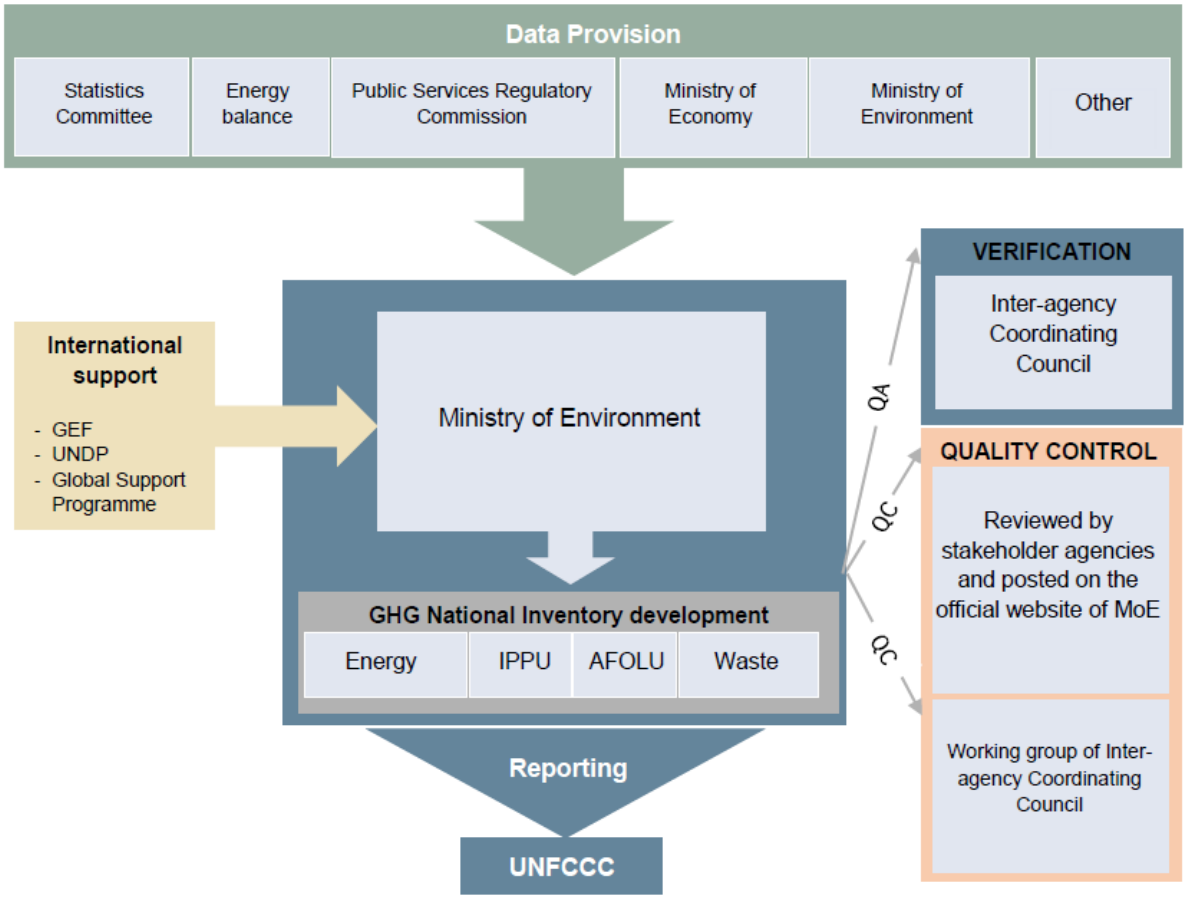
3.1.4 Legal basis for the production of the LULUCF Inventory

78. Since the ratification of UNFCCC (1993), the Government of Armenia once every five years assigns action plan and responsible agencies for implementing the country's commitments under the UNFCCC. The latest plan approved by Government Protocol Decree N 49-8 of December 8, 2016 period 2017-2021, among other commitments states development of GHG Inventories every 2 years.The Ministry of Environment is the statutory entity responsible for fulfilling commitments under UNFCCC. (Republic of Armenia, 2020a).

79. National climate change policies are coordinated by the *Inter-agency Coordinating Council for Implementation of Requirements and Provision of the UN Framework Convention on Climate Change*, (established in 2012). It is chaired by the Minister of Environment and composed of representatives of ministries, state agencies and independent bodies. The Council coordinate reporting on climate change approves the final drafts of reporting documents and inventory. Under this Council, a Working Group, with technical professionals, ensures technical cooperation. At the time of the redaction of the last National Inventory report, the Inter-agency Coordinating Council composition was being revised (Republic of Armenia, 2020a). The UNDP also supports the country to fulfill its obligations under UNFCCC.

80. The following figure has been produced in the 2020 national GHG inventory report (Republic of Armenia, 2020a).

Figure 5: Institutional arrangements of GHG inventory production in Armenia



81. The Republic of Armenia has produced several official inventory reports in the framework of the UNFCCC. The table below presents a summary of these reports.

Table 6: List of GHG inventory reports and other climate documents reporting under UNFCCC

Date of publication	Reported period	Context / document	LULUCF
1998	1990-1995	1st NC	Included
2010	1990-2006	2nd Nat. Comm.	Included
2010	2000	NIR #1	Included
2012	2011-2012	NIR #2	Included
2014	2010	NIR #3	Included
2015	2000-2010	3rd Nat. Comm.	Included
2015	2015-2030	Paris Agreement - INDC	Included
2016	2011-2012	1st BUR	Included
2016	2000-2016	NIR #4	Included
2017	2014	NIR #5	Included
2018	2013-2014	2nd BUR	Included
2019	2015-2016	NIR #6	Included
2020	1990-2016	4th Nat. Comm.	Included

A list of national reports can be found on the website of the MoE: http://www.nature-ic.am/en/publications/NationalReports/0/0 and on the UNFCCC site.

3.2 LULUCF role in the national climate policy

3.2.1 General context of Armenia's national climate policies

82.The Republic of Armenia ratified the UN Framework Convention on Climate Change (UNFCCC) in May 1993 as a developing country not included in Annex I to the Convention.

83. Armenia already submitted its first NDC the 22 September 2015 (Republic of Armenia, Government, 2015b), with the objective to keep an average emission of 5,4 tCO_{2eqv} per capita for the period 2015-2050, with an aggregate budget of 633 $MtCO_{2eq}$ for this period; and its last Biennial Update Report in 2018.

84. Armenia's Long-Term Low Emission Development Strategy (LT-LEDS) is still to be produced and submitted.

85. Several policy documents aim to reduce the country's GHG emissions. They are targeting specific sectors, such as Energy (for example the RA Government Programme and the strategic programs for energy sector development adopted in 2021), Transports, Industry, Waste, Agriculture, and Forestry (Republic of Armenia, Ministry of Environment, 2020b).

86. The Government of Armenia is currently supported by the EU4Climate Programme, to take actions against climate change. This support, funded by the European Union, is implemented by UNDP. In the EU, a new regulation (2018/841) now ensures that accounted emissions from land use are entirely compensated by an equivalent removal of CO_2 from the atmosphere through action in the sector ("no debit" rule).

3.2.2 Role of LULUCF sector

87. Among all sectors involved in limiting climate change and developing resilience, the Land Use, Land Use change and Forestry (LULUCF) sector and the agriculture sector have a central role to play. As stated in the Paris Agreement, these sectors' contribution is essential to reach the long-term climate mitigation and adaptation objectives, especially to achieve carbon neutrality. Currently, the LULUCF sector offsets only 4% of the country's emissions.

88. In its first NDC (Republic of Armenia, Government, 2015b), the LULUCF sector is included in the general mitigation objective, with the aim to reach 20,1% of forest cover by 2050 (according to the Government Decision No 1232 of 21 July 2005) but also with the objective to ensure organic carbon conservation, accumulation and storage in all categories of lands.

3.2.2.1 Forest legal framework and climate strategy

89. The current RA's legal and policy framework for forests is relatively new. Most of the RA's forest-related legal documents were established in the 2000s, while several other international action plans and commitments, including climate change mitigation, related to forest protection and conservation have been developed over the past decade.

90.In 2004, the "National Forest Policy and Strategy of the Republic of Armenia" was elaborated which officially recognizes the importance of forest degradation, biodiversity loss and desertification in Armenia due to ineffective forest management practices during the

last ten years and therefore defines activities aimed at ensuring the restoration and sustainable use of degraded forest ecosystems and forest development.

91. In 2004, the "Action Plan for the Mitigation of Illegal Logging Problems" was adopted, which recognizes the importance of reducing the volume of illegal logging and taking into account the economic and social aspects of forests (UNECE, 2005). Since the majority of illegal logging is conditioned by the poverty of the rural population, the program for the prevention of illegal logging has been based on actions to reduce poverty.

92. The 'National Forest Program' (NFP) of the RA developed in 2005 with the aim 'to guard forest ecosystems, rehabilitate degraded forest ecosystems, use forest resources in a continuous and efficient manner and ensure sustainable forest management strategy' (Republic of Armenia, 2005a). The NFP will be at the origin of the new forestry code of the same year. It also created a National Forest Program Coordination and Monitoring Board.

93. The main objective of the 2005 Forestry Code (Republic of Armenia, 2005b) is to establish general and official definitions and rules concerning the classification of forests, forest uses, forest practices and management, forest ownership and inherited responsibilities, the role and institutional bodies of control and monitoring of the RA's forests. The intentions of the code are definitively oriented towards the principles of sustainable forest management, balancing economic, social and environmental criteria to ensure sustainable development of the forest sector.

94. In 2006, the 'Law on Specially Protected Nature Areas' was adopted with the objective to "set forth the legal principles of State Policy for sustainable development, restoration, conservation and use of ecosystems, nature complexes and separate objects of Specially Protected Natural Areas of the Republic of Armenia representing environmental, economic, social, scientific, historical-cultural, aesthetic, health, climate regulating, recreational and spiritual values" (Republic of Armenia, 2006).

95. In 2013, the RA Government adopted the Decree No. 563-A "On Approving the National Action-oriented Program for Improvement of Fire Safety in Forests and Vegetated Areas and the List of Complex Measures Aimed at Improving Fire Safety in Forests and Vegetated Areas". The program is aimed at reducing the risks of forest and other vegetation fire and climate change impacts on forest ecosystems, as well as significant enhancement of forest and other vegetation fire management (Republic of Armenia, Ministry of Environment, 2020b).

96. In 2014, the State program and strategy on Specially Protected Natural Areas (SPNA), their conservation and use of RA was developed (Republic of Armenia, 2014). In particular, this strategic document defines the institutional framework related to biodiversity of the State Non-Commercial Organizations (SNCOs) responsible for the protection of SPNAs.

97. In 2015, the "National Strategy and Action Plan for 2016-2020 on the Conservation, Protection, Reproduction and Use of Biological Diversity" was approved within the framework of the Convention on Biological Diversity (Republic of Armenia, 2015a). The main objectives of this strategic document are to define actions and timetables for their implementation in order to promote the achievement of the priority strategic objectives of biodiversity conservation and management in RA.

98. In 2015, the Republic of Armenia provided its national determined contributions in the framework of the Paris Agreement under United Nations Framework Convention on Climate Change (UNFCCC) (Republic of Armenia, 2015b). The forest sector is officially included as a main sector for the country's contribution to mitigation. Within the framework of the INDC, the Republic of Armenia has set a target to increase forest cover to 20.1% of the territory by 2050.

99. For consolidating forest protection measures, it is also envisaged to carry out technical upgrading of the forestry workforce, create prompt fire response teams, among other activities. By the Decree No. 45-A (dated January 22, 2015), the RA Government approved the "National Policy on management of wildfire in forest lands, especially protected areas, agricultural lands and settlements, the strategy for its implementation and the list of measures". Its purpose is to enhance the capacity of prevention and response to wildfire (monitoring and information system, rapid fire prevention measures, etc.) (Republic of Armenia, Ministry of Environment, 2020b).

100. In 2017, Armenia ratified the Paris Agreement and made quantitative commitments to limit GHG emissions. Armenia's position under the Paris agreement is set out in the "national contributions" which recall its commitment in terms of national forest cover to be reached by 2050.

101. By Protocol Decree No. 50, dated November 30, 2017, the RA Government approved the "Concept, Strategy and List of Measures for Forest Sector Reform" aimed at balancing social and economic needs, as well as climate and environmental requirements[14].

102. A recent government program of the RA has set in 2019 "forest conservation, sustainable management, woodland expansion, reforestation, afforestation and continued capacity building as key priorities in the context of environmental management"[15].

103. In 2020, a new National Forestry Program was launched, aimed at expanding the forest area covered by Armenia to 20.1% of the country's territory by 2050 in order to reaffirm and begin the implementation of international commitments under the UNFCCC[16].

3.2.2.2 Agricultural land legal framework and climate strategy

104. Since methane emissions from enteric fermentation are key category subsector in the AFOLU sector, a number of projects and concepts have been approved by the Government to promote animal husbandry separate branches, including those, which contribute to reducing GHG emissions from farm animals and mitigating climate change. Methane emissions from enteric fermentation are attributable to the type of farm animals, their genotype (breed, race), live mass, feed composition, care conditions, climate, as well as methods of manure preservation and processing. Although no specific measures are yet implemented in Armenia for the reduction of methane emissions from ruminant enteric fermentation and manure accumulation, the recent projects supported by the RA Government have been indirectly contributing to the reduction of emissions from animal

[14] More information at: http://www.mnp.am/en/post/2768 consulted on 12/31/2020
[15] https://www.gov.am/files/docs/3133.pdf
[16] More information at: http://www.mnp.am/en/post/5428 consulted on 12/31/2020

husbandry (4th National communication, 2020). These include Stockbreeding Development Program (2007), Cattle Breeding Development Program (2019-2023), Program on Establishment of Slaughter-houses (2008-2015), Reduction in the duration of animal exploitation due to premature breeding for example the Strategy for Agricultural and Rural Sustainable Development (approved by the RA Government Decree No. 1476-N, dated November 11, 2010). These Livestock issues are not really covered by the LULUCF sector under Cropland nor Grassland. The new agriculture strategy adopted for 2020-2030 (Razmavarutyun et al, 2020) especially focuses on climate change adaptation an on modernization of agriculture (digitalization, mechanisation, climate smart agriculture practices), which may impact practices on cropland and grassland and also raise the land reform as a way to encourage agriculture and good practices.

105. The Government is developing a legislative package to include unused arable land into crop rotation, with an instrument to oblige the landowners to cultivate the land under their possession or to lease it, if own cultivation is not practicable. (Republic of Armenia, 2020b).

106. Actions are taken to tackle the issue of degraded lands and desertification. In, 2015 the National Strategy for Combating Desertification and the National Action Plan was ratified by the GoA Decree No. 23, in order to prepare future legislative improvements, public awareness and international cooperation.

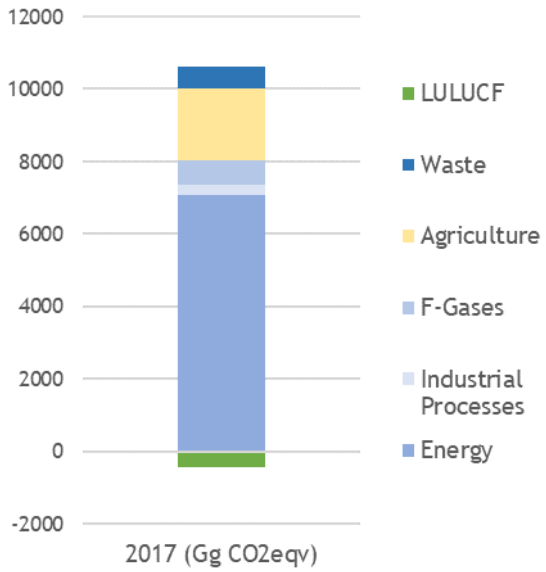
107. In 2018, the RA Law on Making Amendments to the RA Land Code was adopted by the National Assembly, according to which the terrestrial land cover of the country is classified in 6 diverse classes: 1) cultivated lands; 2) meadows; 3) wooded areas; 4) bushy areas; 5) waterlogged areas; 6) areas devoid of vegetation. According to the GoA Decree No. 431-N, dated April 11, 2019, "On Approving the Procedure for Classification of Terrestrial Area Coverage in the Republic of Armenia". It is envisaged to have data on terrestrial land area coverage at the community level with annual breakdown. The aim is to contribute to the sustainable use of land resources (Republic of Armenia, 2020b).

108. In the context of the global goal of Land Degradation Neutrality by 2030, Armenia has developed a degradation neutrality strategy, with four targets: stopping cropland degradation and promoting agroecology; afforestation and/or reforesting two-third of the degraded land; stopping deforestation and improving forest management all across the country; stopping overgrazing and improve grassland management all across the country (FAO, 2020b).

4. Current LULUCF inventory

109. According to the last GHG inventory report (Republic of Armenia, 2020a), the country total CO_{2eqv} emissions (excluding LULUCF) amounted to 10 624 Gg CO_{2eqv} in 2017, while the LULUCF sector represented a net sink of -444 Gg CO_{2eqv} in 2017. Therefore, the LULUCF sector allowed in 2017 to offset 4% of the emissions of the other sectors. In the context of the global objective of climate neutrality, reducing emissions but also increasing the LULUCF sink capacity is of crucial importance.

Figure 6: 2017 GHG emissions of Armenia



4.1 Land-use

110. The national GHG inventory report (Republic of Armenia, 2020) describes the procedure to reallocate the national land use classes (from the RA land balance) into the 6 IPCC categories. This implies the subdivision of categories (for example, home garden plots and gardening lands are divided, for 40% into cropland and for 60% into settlements), which is feasible for an approach 1 to land use monitoring (statistics table only) but may not be easily done with a more accurate approach such as a spatially explicit one.

111. A matrix related to 20 year of changes is presented in the NIR, where few land use changes are presented. According to this matrix:

- 1,467 ha are converted from cropland to other land between 1997 and 2017.
- 940.4 ha are converted from cropland to forestland between 1997 and 2017.
- 122 ha are converted from cropland to grassland between 1997 and 2017.
- 26.8 ha are converted from forestland to other land between 1997 and 2017.

Figure 7 : 2017 land use change matrix (Republic of Armenia, 2020)

Final\Initial	Forest land	Cropland	Grassland	Wetland	Settlement	Other Land	Total Final
Forest Land (Forest Covered)	349,000.2	940.4					349,940.6
Cropland		572,620					572,620.0
Grassland		122	1,459,627.5				1,459,749.5
Wetland				9,852.6			9,852.6
Settlement					110,305.7		110,305.7
Other Land	26.8	1,467				470,298	471,791.7
Total Initial	**349,027.0**	**575,149.4**	**1,459,627.5**	**9,852.6**	**110,305.7**	**470,298**	**2,974,260.1**
Net Changes	**-26.8**	**-2,529.4**	**0**	**0**	**0**	**0**	**0**

4.2 Forest land

4.2.1 Forest biomass and growth

112. According to the national GHG inventory (Republic of Armenia, 2020), the biomass stock for the Armenian forest is estimated at 99.3 tons per hectare divided between 80.72 tons of above-ground biomass and 18.58 tons of below-ground biomass.

113. In the national GHG inventory (Republic of Armenia, 2020), biomass carbon stock variations are estimated with Gains-Losses method.

114. In absence of recent forest inventory, the annual average biomass growth of Armenian's forest is estimated to 1.5 m3/ha/year corresponding to 0.835 tonnes d.m./ha/year of above ground biomass and 0.192 tonnes d.m./ha/year of below ground biomass for a total of biomass of 1.027 d.m./ha[17] (Republic of Armenia, 2020). According to FAO, cited by Pasoyan & Sakanyan (2019), the maximal forest renewal increment is estimated at 600,000 m3/year, which is based on forest renewal capacity of annual growth rate of 1.30-2.86 m3/ha/year. Due to natural disturbances, the growth rate is even slower.

115.The critical reference for annual growth measurements for Armenian forests was SIDA funded project in 1997-1999. According to that study and according to measurements on around 280 sample plots, annual growth was 2,9m3/ha, which was almost twice more than values retained for inventory which is 1,5 m3/ha.

116.Losses are based on national data on harvest in forests, even if uncertainty on wood removals remains high considering the difficulties to estimate possible illegal loggings.

117. Factor estimates face uncertainties due to the lack of regional data on wood density and biomass expansion factors by stand, species composition and structure. Therefore, the weighted average wood base density and biomass expansion factors for Armenian forestry

[17] According to regional surveys the basic wood density is estimated to 0.557 of oven-dry tonnes/moist cubic meter. Otherwise, below-ground biomass to above-ground biomass ratio (R) provided for temperate climatic zone and temperate mountains systems ecological zone in 2006 IPCC Guidelines was used corresponding to 0.23 tonne d.m. /(tonne d.m.). Finally, carbon fraction of dry matter is set to 0.48 tonne C/(tonne d.m.).

are set within the range of the default parameters of the IPCC guidelines (i.e. Tiers 1 method).

118. In absence of reliable data on dead-wood and litter carbon stock in Armenia, these pools are not taken into account in the national GHG inventories. It should be noted, however, that Forest Resources Assessment of Armenia (FAO, 2020a) reveals an estimate of Armenian forest carbon litter of 28.16 tons and soil carbon of 36.81 tons per hectare.

4.2.2 Current Net Global Forest sector impact

119. Consistent with the methodology of the 2006 IPCC Guidelines (IPCC, 2006), the latest National GHG Inventory of 2017 (Republic of Armenia, 2020) estimates emissions and removals from forest land from two sub-sectors: (i) remaining forest land and (ii) land converted to forest land.

120. According to IPCC (2006), Forest Land remaining Forest Land (3B1a) that concerns forest lands that have not undergone land use change during 20 years prior to the accounting year. The area of these type of forests was officially estimated in Armenia to 348,060 ha in 2017. Applying biomass annual growth factors of 1.5 as described in section 1.2.4.1, the total gain of biomass in 2017 reached 522 090 m3 equivalent to 171 588 tons of carbon[18].

121. In addition, according to the principle of Gain-loss of biomass, the following component have been take into account as emissions in this sub-sector 3B1:

- Annual volume of harvested fuelwood corresponding to 85 373 m^3 equivalent to 28 060 tons of carbon.
- Annual volume of timber harvested estimates to 3 314m^3 equivalent to 1 090 tons of carbon
- Burned areas estimates to 895 hectares equivalent to 440 tons of carbon.

122. Land converted to forest land (3B1b) corresponding to the lands in transition stage and as a result of land use change during 20 years prior to accounting year converted to forest lands. In 2017, these areas was estimated about 940 ha according to the last national GHG inventory for an annual gain of biomass of 1 410m^3 equivalent to 464 tons of carbon.

123. Otherwise, the others sub-sectors leading to a conversion of forest lands to grassland or cropland are not take into account in the last national GHG inventory. The only recorded forest conversion comes from the '**Forest land converted to other lands**' sub-sector (3b6b) representing only 26.8 hectares or 40 m^3 of biomass equivalent to 13.2 tons of carbon.

124. Following table summarizes current states if emissions and removals involving forest sector and according to the last national GHG inventory (2017).

[18] According to the formula used in national GHG inventory: surface ha x (1.5 m^3/ha x 0.557 oven-dry t/moist m^3 x 1.23 ton d.m x 0.48 tC/ (ton d.m.)

Table 7: Summary of 2017 GHG inventory for forest sector in Armenia

Sub-sector	Surface (ha)	Volume (m3/yr)	eq. Tons of Carbon/yr	CO2 Gg /yr (+) emissions (-) removals
Forest growth	348 060	522 090	171 588	-629
Harvested fuelwood	-	85 373	28 060	103
Timber harvested	-	3 314	1 090	4
Burn areas	895	1 343	440	2
Land Converted to Forest Land	940	1 410	464	-2
Forest land converted to other lands	26,8	40	13	0
			Balance	**-522**

125. There is a lack of complete and reliable data on the recent evolution of forest lands due to the absence of a forest inventory for nearly 30 years. Latest data are from Forest accounting in 1993 (used to be every 5 years between forest inventories, which used to be in every 10 years), but last inventory took place in 1986-1989. As a result, activity data, particularly on deforestation, afforestation, reforestation and disturbances caused by fire, insects and disease are highly uncertain in current estimates (Republic of Armenia, 2020).

126. In particular, much of the uncertainty is mainly due to the lack of complete and accurate information on natural wood losses and removals of fuelwood resulting from illegal logging. The information available on fuelwood removals from different sources such as primary sources and household surveys differs significantly.

4.2.2.1 Estimates gross emissions and removals trends from forest losses and gains

127. Today, the accounting of forest emissions and removals is assessed on a gross basis in relation to the overall change in forest cover. For a finer analysis of the sources of emissions and removals involving forests in Armenia and thus of the potential for reducing emissions, it would be necessary to conduct (i) a rough analysis of forest dynamics by identifying forest gains and losses independently with (ii) time series to assess historical trends or possible breaks in trends in order to refine the current situation and anticipate plausible trajectories. For this purpose, it is necessary to further develop the current national inventory estimates using spatial data on land use and forest trends in Armenia. Specific other projects on land-use, for the whole country or specific regions, using satellite imagery products, could also be used for this analysis.

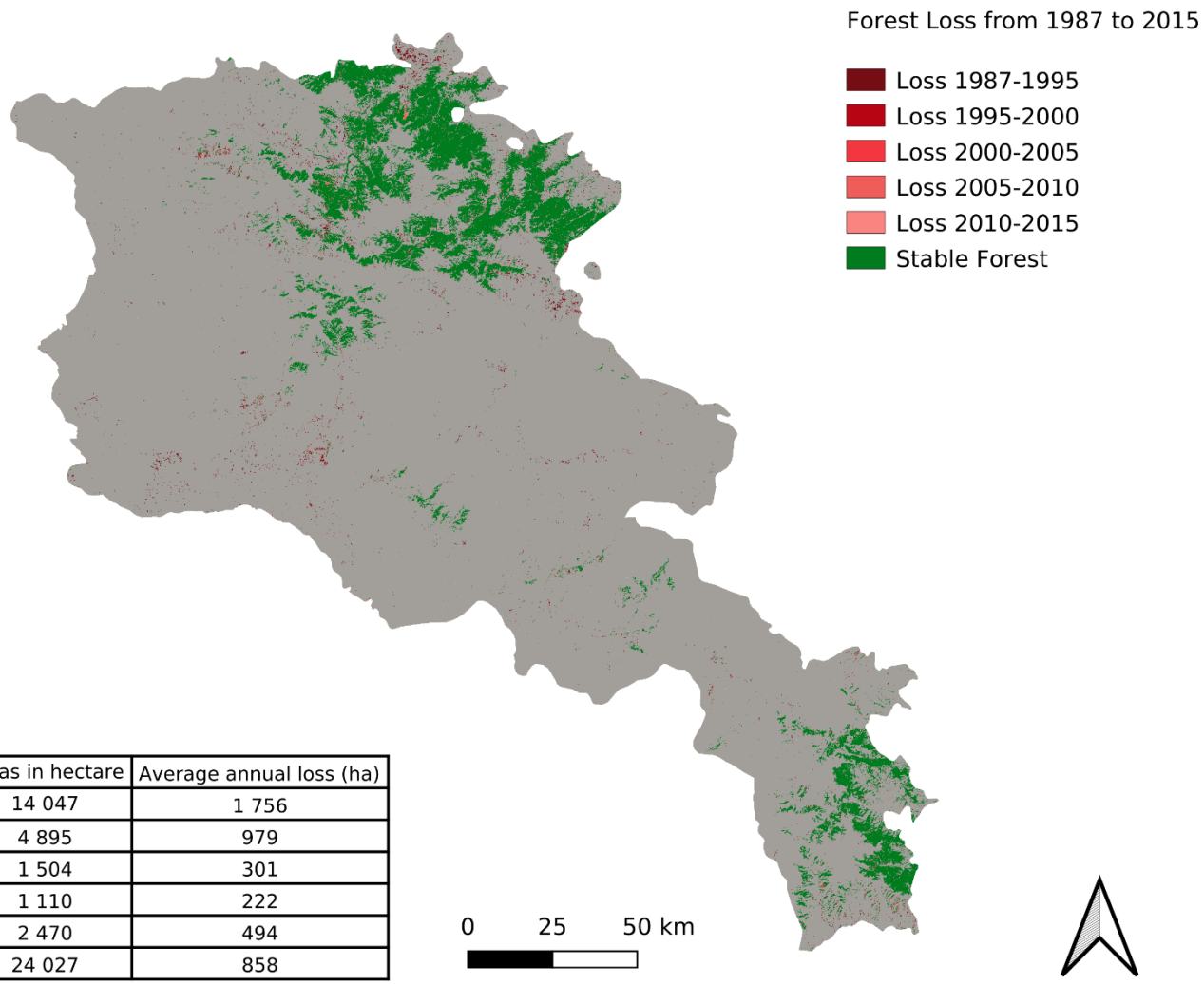
128. In the absence of an official spatial data set, an analysis was carried out using Buchner et al. (2020) data already used and described in section 1.1.4. Particularly, the uses of the spatial data should help to complete lack of estimations about:

- Forest land converted to other lands determining possible deforestation activities,
- Other land converted to forest land related to forest gain through afforestation and/or reforestation or natural regeneration activities.

129. As already mentioned, being aware that some differences may appear between the official data and the remotely sensed data used, due to different classification of land cover and land use, or misclassification of remote sensing, the objective is not to reassess the emissions balance of the forest sector in Armenia, but simply to identify orders of magnitude on currently unmentioned activities and thus assess their potential contribution to the emission reduction strategy.

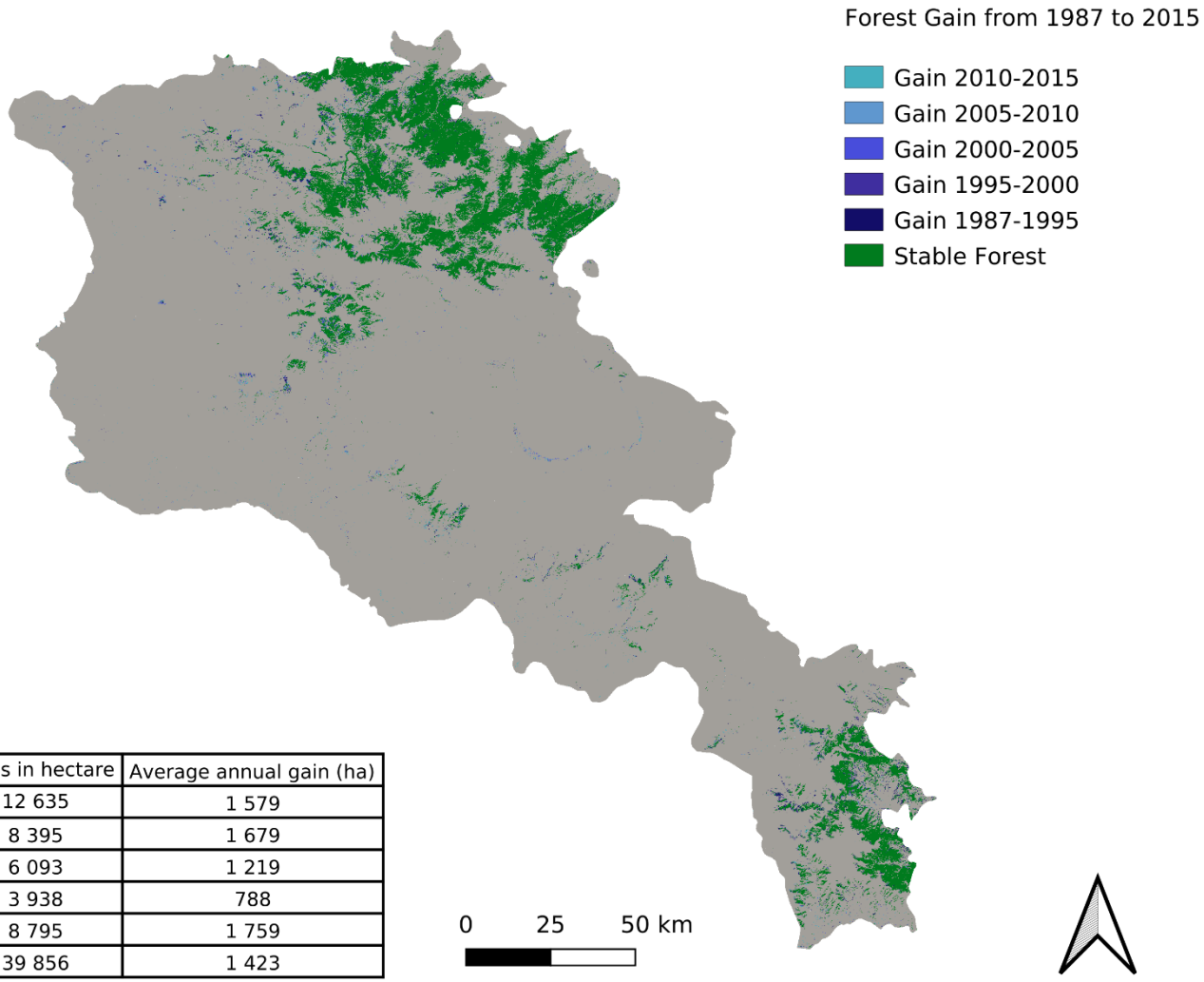
130. According to the data used (Buchner et al. 2020), the figures 5 and 6 illustrate forest gain and forest loss in Armenia, respectively, during 5 successive periods: 1987-1995, 1995-2000, 2000-2005, 2005-2010 and 2010-2015.

Figure 8: Forest losses from 1987 to 2015 according to spatial data of Buchner et al. (2020)



Forest losses (periods)	Areas in hectare	Average annual loss (ha)
1987-1995	14 047	1 756
1995-2000	4 895	979
2000-2005	1 504	301
2005-2010	1 110	222
2010-2015	2 470	494
1987-2015	24 027	858

Figure 9:Forest gains from 1987 to 2015 according to the spatial data of Buchner et al. (2020)



Forest gains (periods)	Areas in hectare	Average annual gain (ha)
1987-1995	12 635	1 579
1995-2000	8 395	1 679
2000-2005	6 093	1 219
2005-2010	3 938	788
2010-2015	8 795	1 759
1987-2015	39 856	1 423

131. Overall, even with the addition of data on deforestation and forest regrowth, the estimates are very close to the national GHG inventory for the forest sector in 2017, arguing for offsetting each of these two activities over time. Moreover, this in-depth spatio-temporal analysis has confirmed that in Armenia (i) annual emissions due to deforestation are low, as well as (ii) removals due to afforestation/reforestation or natural regeneration.

132. Finally, the results of the analysis suggest a relative stability in forest emissions/removals over the period 1987-2015, which argues in favor of a flat baseline as plausible business-as-usual scenario.

4.3 Cropland and Grassland

133.Carbon stock change in biomass and soil, for Cropland remaining Cropland, is estimated based on carbon Gain-Loss Method by using Tier 1 method considering land use type, area, cultivated crops and climatic zonal distribution. The inventory is made for all lands that have not undergone essential changes in terms of land use during recent 20 years.

134. Considering that Grassland is not a key source and data on grassland management practices are not available, the Tier 1 assumption of no change in biomass was applied [Gen-1, Volume 4, Chapter 6]. The assumption in Tier 1 is that the biomass in all Grassland Remaining Grassland is stable.
135.Emissions and removal in this sub-category are estimated based on carbon stock change in mineral soils.

4.4 Settlements, Wetlands, Other lands

136. Settlements is not a key category and emissions assessment was done applying Tier 1 method which assumes no change in carbon stocks in live biomass in Settlements Remaining Settlements, in other words, that the growth and loss terms balance.

137. Other land category includes unmanaged reserve lands, bare soil, rock, ice, and all land areas that do not fall into any of the other five categories, i.e. lands without vegetation. Other Land is often unmanaged, and in that case changes in carbon stocks and non-CO2 emissions and removals are not estimated.

4.5 Overview of LULUCF sinks and sources

138. The following tables, from the 2020 inventory report (relative to 1990-2017), summarizes for each LULUCF subsector, the sources and sinks of GHG.

Table 8: Synthesis of Emissions and Removals from LULUCF categories in 2017

	CO_2 emissi-ons, Gg	CO_2 removals, Gg	CH_4 emissi-ons, Gg	N_2O emissions Gg	Total emissions Gg $CO_{2\,eq.}$
Categories	**93.88**	**-537.99**		**0.00138**	**-443.68**
A. Forest land	**NO**	**-530.44**			**-530.44**
1. Forest land Remaining Forest land	NO	-523.92			
2. Land Converted to Forest land	NO	-6.53			
B. Cropland	**0.67**	**-7.40**			**-6.73**
1. Cropland Remaining Cropland	0.67	NO			
2. Land Converted to Cropland	NO	-7.40			
C. Grassland	**18.37**	**NO**			**18.37**
1. Grassland Remaining Grassland	NO	NO			
2. Land Converted to Grassland	18.37	NO			
D. Wetlands	**18.32**	**NO**		**0.00138**	**18.75**
1. Wetlands Remaining Wetlands	18.32	NO		**0.00138**	
2. Land Converted to Wetlands	NO	NO		NO	
E. Settlements	**NO**	**-0.15**			**-0.15**
1. Settlements Remaining Settlements	NO	NO			
2. Land Converted to Settlements	NO	-0.15			
F. Other land	**56.52**	**NO**			**56.52**
1. Land Converted to Other land	NO	NO			
2. Cropland Converted to Other Land	56.52	NO			

Conclusion

The following issues, based on the elements presented in this background report, shall be considered in the next deliverables (technical report & policy note) when identifying mitigation options for the LULUCF sector in Armenia:

- The wood and in particular fuelwood supply legal and illegal, is a crucial issue in terms of data uncertainty, forest management, law implementation, calculations, and mitigation strategy. It can be noted that « briquettes« production in Armenia and its import from Russia are also in development. The degradation of the Armenian forest due to high rates of wood removals shall be taken into account in the considerations to maximize the sink potential of the forest.
- Institutional and legal framework for forest protection and management may be also a way of improvement to strengthen the implementation of the forest policy and laws.
- Data collection for land-use and for forest parameters (growth, mortality, wood removals) shall be improved in the future and to better estimate the potential of LULUCF sector in Armenia. Improved new datasets and a proper monitoring system are needed.
- Since the forest area is now very limited, and since afforestation and reforestation are one aim of the country in its climate pledges, afforestation and reforestation will be key actions to consider.
- Forest management to mitigate its degradation and to improve its productivity, with the aim to develop productive and traditional tree species, and to continue developing sustainable forestry practices, will also be a key element.
- Restauration and conservation of agricultural soils, which suffer from erosion and desertification, are also an important part of a LULUCF strategy to avoid further losses of soil carbon stocks. In particular, irrigated lands and subalpine and alpine meadows, are to be considered. Some suggestions in literature to improve cropland management, avoid soil erosion and desertification (Markosyan et al. 2013; GEF-WB, 2014 ; Ghazaryan & Kroyan, 2016)

Annex I
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