The Economics of Armenia's Forest Industry

ACKNOWLEDGEMENTS

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TABLE OF CONTENT

1. INTRODUCTION

Armenia is one of the 70 *low forest-covered countries*, as its forests cover less than 10% of the total land area. Hence the continuing deforestation of already scarce forest resources presents a significant environmental threat, combined with destroying consequences for habitats, irreversible losses of biodiversity, lost revenue of the government from the alternative benefits of the forest (e.g. tourism development).

This paper provides a perspective on the characteristics of the wood processing industry of Armenia, the wood consumption volumes and purposes in Armenia, analyzes the major consumption patterns by the local wood processing industry and the households, identifies the major obstacles of the sector, outlines the development outlook in the context of further economic development and the evolvement of the local household needs, and, based on the observation of current local settings and the international benchmarks, proposes several solutions in reference to the development of Armenia's wood processing industry, along with the retainement and sustainable development of the forest stock of the country.

The economic crisis and the drastic socio-economic conditions, along with the poor implementation of forest management and monitoring policies throughout the last 15 years have resulted in massive deforestation of the country. Due to the strengthened state control during the recent years the logging volumes have decreased. However, the overall decrease of the forest resources is still progressing, despite the major efforts of Hayantar, along with international organizations and local NGOs towards intensive reforestation (the reforestation during the years of 2000-2005 was about 7,500ha, National Statistical Yearbook of RA). Thus, the issues of efficient forest management and sustainable forest stock development are inevitably essential.

This paper attempts to analyze the forest cover and forest stock dynamics in Armenia through the study of satellite image data. This methodology is widely accepted in numerous developed countries as a means of quantifying and managing the forest and water resources, as well as other geological purposes both in scientific and practical reasons. The analysis and estimations of the wood consumption for different purposes in Armenia are implemented based on the official statistics, market research, data on electricity and natural gas consumption rates by households.

It should be noted that some of the data brought forward in this research are estimates and are included to enable the reader to project reality with some level of accuracy.

Based on the current issues of the forestry management sector and the international experience we propose the following solutions:

1. Ease the access of gas supply for the rural residents through micro credits and lessening the initial installment costs.

2. Exempt the industrial roundwood imports from VAT.

3. Establish an integrated timber market and wood industry association.

4. Impose an export ban on industrial roundwood.

5. Facilitate tree farming.

6. Promote recycling and renewable energy production.

7. Enhance eco-tourism, NWFP and forest services sectors.

8. Develop green consumerism.

9. Enhance the capacities and the knowledge base of the Forest Monitoring Centre (FMC).

10. Implement forest certification and the chain of custody tracking procedures.

11. Tighten the policy and regulation enforcement.

12. Coordinate forest sector development projects and initiatives.

13. Control financial flows of the wood processing industry.

14. Consider the creation of a consultancy body within the organizational structure of Hayantar to include the opinions of key stakeholders in the decision-making process.

2. THE DYNAMICS OF FOREST RESOURCES

A major factor affecting the development of the forest sector is the quantity and quality of forest resources and the way that those resources are managed to provide benefits for society. The official inventories, however, are not a reliable source of measuring quantities [1]; furthermore, the last official inventory was undertaken during the period of 1986-1989.

The estimations of forest stock and deforestation dynamics in the current research are based on the analyses of the forests' satellite image data ("Landsat" images), which is an independent alternative to the official statistics. The information on any doubtful areas throughout the satellite image analysis was double-checked via area maps, field visits and local experts. The detailed description of the methodology is presented in Appendix 1.

The state decree on "Forestry management plans" (certified by N130-n order of the Agriculture Minister of RA, on 10.09.2005) that coordinates the processes of forestry development and planning in the Republic of Armenia, states that "the satellite image data are considered the technical basis of the forestry development process".

The findings

The total forest cover of Armenia is estimated at **9.8%** of the area or equal to 294,134 ha on the base of Landsat TM sensor for 1988, as opposed to the officially accepted version of **11,2%.** The estimation of **246,098 ha** forest cover (on the base of Landsat ETM+ sensor from 2000) is very close to other estimates of independent sources (245,000 ha Thuresson, 2003; Sayadyan, 2005). The latest estimation of the forest cover on the base of Landsat ETM+ sensor from 2006 is **7.7%** (232,000 ha). Thus, the annual deforestation rate for the period of 2000-2006 was about 2,400 ha of the forest cover.

A major feature of deforestation process is the accelerated rates of forest **fragmentation**. The increasingly complex shapes of large forest patches distort the forestry estimates: the forest degradation continues leaving the surface of forest cover relatively unchanged.

Deforestation is especially "clear-cut" around the large cities (see Figures in Appendix 3), as well as in the surroundings of Lake Sevan. According to our classifications, 1,888 ha of forests have disappeared within two kilometers of the shores of Lake Sevan. This is clearly visible in the south shores of the lake (see Figures in Appendix 3) reinforcing the same report by Moreno-Sanchez and Sayadyan (2005). Deforestation has been more prominent in the forest areas in the north of the country (north of Lake Sevan) than in the forests in the south.

The reforestation rates have dropped significantly, despite the extensive increase in recent years. While during 1970s-1980s the reforestation reached about 3,000-5,000 ha annually, the average reforestation figure reported officially in 2000 - 2005 was 1,250 ha annually.

We conducted a change detection analysis using a post-classification analysis approach in which the spectral classifications for t_1 and t_2 produced independently are compared (Mass, 1999). This approach has been reported to produce high accuracy results, when two images with high accuracy (3%) classifications are compared (Mass, 1999). The Image Analysis

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[1] The accuracy concerns are clearly stated by the National Forest Program of 2004 which stated that the National Forest Inventory of 1986-1989 was not done properly, and that it was mostly an extrapolation of the 1976-1979 National Forest Inventory results.

extension of ArcGIS 9.1 was used to compare the Boolean (forest/non-forest) images from 2000-2001 with the Landsat 5 images of the 1987-1989 period.
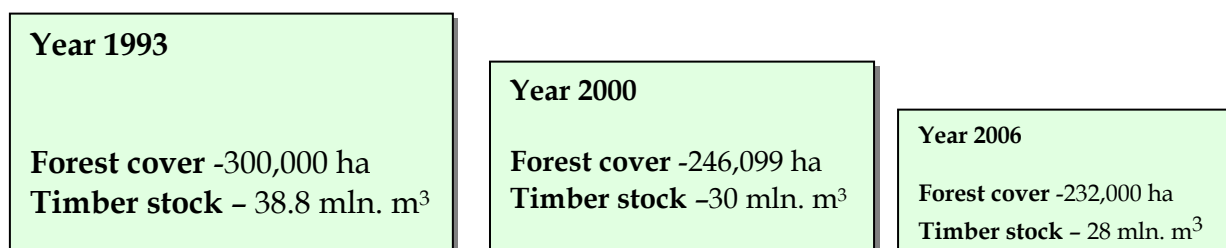
The following table summarizes all available data from different sources on the forest cover extent of the RA.

Table 1: Summary table of the forest cover dynamics in Armenia as per different sources.

Period	References	Forest cover (ha)	% of total area	Estimated timber volume (1,000 m³)	Estimated volume per ha (m³)
4000 to 1 B.C.	Moreno-Sanchez, R&Sayadyan,H.2005	Approx. 1,050,000	35	N/A	N/A
17-18 Centuries	Makhatadze, 1977; Maghakyan, 1941; Moreno-Sanchez, R&Sayadyan,H.2005	Approx. 530,000	18	N/A	N/A
1941	Maghakyan	284,379	9,6	N/A	N/A
1960	Abrahamyan	241,753	8,1	24,838	102,7
1966	National forest inventory data	253,000	8,5	29,700	117,4
1977	Makhatadze	273,000	9,2	27,892	102,2
1978	National forest inventory data	296,600	9,89	31,140	105,0
1987-1988	Landsat-5 TM images (EV analysis)	294,134	9,8	Approx. 33,830	115,0
1987 - 1988	Topographic maps 1:100,000	284,950	9,5	Approx. 32,770	115,0
1993	National forest inventory data	334,100	11,2	41,740	124,9
1993	Ter-Ghazaryan et al,[2]	300,000	10,0	38,810	129,3
2000	Thuresson, 2003; Sayadyan, 2005	Approx. 245,000	8,2	Approx. 30,000	122,4
2000	Landsat ETM+ images (EV analysis)	246,099	8,2	Approx. 30,123	122,4
2006	Landsat -5 TM image (EV analysis)	232,000	7,7	28,000	120,7

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[2] According to Ter-Ghazaryan et al. 1995, the size of reforestation since 1960 was 60,000 ha, meaning that forest cover by early 1990s, i.e. before mass illegal logging was around 300,000 ha or 10% of total area, which is reinforced by the Landsat TM data and Soviet era topographic maps. The annual growth increment is estimated at about 390,000m³.

The following figure summarizes the dynamics of forest cover and timber stock according to the satellite image and literature data analysis.

Year 1993

Forest cover -300,000 ha
Timber stock – 38.8 mln. m³

Year 2000

Forest cover -246,099 ha
Timber stock –30 mln. m³

Year 2006

Forest cover -232,000 ha
Timber stock – 28 mln. m³

	Period	
	1994 - 2000	**2001 - 2006**
The annual average net decrease of timber stock (m^3)	1,257,000	333,000
	1994-2006	
The estimated annual natural growth of timber stock volume (m^3)	390,000	
The officially recorded average annual volume of fire disruptions (m^3)	2,500	
	1994-2000	**2001-2006**
Volume of annual timber harvest according to official statistics (m^3)[3]	135,000	122,000
The estimated annual average unreported logging(m^3)	1,509,500	598,500

The annual average amount of logging throughout the years of 2001-2006 was around 720,000m³ (standing volume), approximately half the annual volume of 1994-2000.

Illegal logging

The term "illegal logging" is open to interpretation. It is surprising that there is no official definition of illegal logging in Armenia. However, it is logical to assume that logging associated with violation of the Forest Code and other related laws is considered illegal.
For the purposes of this report, we accept the World Bank definition of illegal logging[4].

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[3] This figure illustrates the total amount of fellings of forests of main use and reforestation fellings, as well as the maintenance and sanitary fellings according to the National Statistical Service of RA (The Statistical Yearbook of Armenia, 2005, 2006; The Environment and the natural resources of RA, 1999). During the period of energetic crisis, the annual legal permitted harvesting volume (Ter-Ghazaryan, K.et al. 1995) was raised to 100,000 m³ in 1993, of which about 45,000 m³ was allocated for fuelwood. In addition, the plan called for the collection of snow-break trees in order to somehow relieve the energy needs of the population. In 1994 approximately 200,000 m³ quota was allocated among the several forest enterprises.

[4] According to the World Bank, illegal logging is the term which applies to cuttings: outside a concession area, in excess of quota, in a protected area, without appropriate permits, without complying with bidding regulations, without submission of required management plans, in prohibited areas such as steep slopes, river banks, and water catchments, that contracts with local entrepreneurs to buy logs from protected areas, removing of under/over-sized trees from public forests, reporting high volumes extracted from forest concessions to mask that part of the volume is from non-authorized areas outside of the concession boundaries, using bribes to obtain logging concessions, using deceptive transfer pricing and other illegal accounting practices to distort prices, volumes, cash flows and debt service levels, that engages in the illegal transport and trade of timber or the smuggling of timber, that is processed with out the required licenses and that is not in compliance with environmental, social and labor laws.

The driving forces

The economic and social environment, in which either on legal or illegal terms timber is harvested, transported, processed, sold and consumed, is broad and a single activity in the forest sector is related to many others creating a multiplication effect.

The household consumption is driven primarily by **poverty**. This suggests that illegal logging for fuelwood will only be decreased when adequately priced modern energy alternatives become available in combination with effective poverty alleviation policies.

The industrial processors cut trees for commercial use, either domestically or for exports. In this case, timber harvesting is driven for **profit** generating purposes and is affected by supply and demand factors. The forecasted increase in demand is caused by the growth of population and prosperity levels. Most wood products other than fuelwood are positively related to income growth.

Timber is a high value product that is relatively *easy to merge* into legitimate market distribution channels. The official limits on legally permitted volumes of timber harvest provide an **incentive** for illegal logging. Illegal logging is driven mostly by financial incentives.

The cost differential between legal and illegal production depends on the characteristics of the markets for wood products. The cost comparison between the illegal and legal material is complicated. The costs of acquiring illegal logs and a higher level of risk add to their cost. On the other hand, tax avoidance can reduce their costs. Furthermore, even more complexity is added due to the very high difference in domestic and international prices of roundwood, as well as due to the mostly government-imposed pricing system in Armenia, which distorts the market dynamics.

The issue of illegal logging has been discussed in numerous studies published during the recent years, most of which make attempts to estimate the volume of illegal loggings. The following summary table illustrates the various estimates of illegal loggings according to various sources (including official sources).

Table 2. The estimates of annual loggings according to various sources.

The source		The annual average logging volume (m^3)*		
		The total volume	Industrial roundwood	Fuelwood
The national forestry plan of RA	Government decree of RA, 21 July, 2005 N1232-n	~700,000	-	-
Ensuring Sustainability of Forests and Livelihoods through Improved Governance and Control of Illegal Logging for Economies in Transition.	Working Document – Armenia For The World Bank, 2005	~1,000,000	432,000	568,000
Issues concerning the new Forestry legislation and the National Forestry Plan,	Nazeli Vardanyan, Mher Sharoyan, "Armenian Forests" NGO, Yerevan, 2005	1,000,000	-	500,000
Illegal Logging – Survey and Analysis,	Ministry of Nature Protection/SIDA, 2004	-	-	min 567,563**

The source		The annual average logging volume (m^3)*		
		The total volume	Industrial roundwood	Fuelwood
Forest Institutional Support Project				
Armenia country profile, 2002, UN	(http://www.un.org/esa /agenda21/natlinfo/wssd /armenia.pdf)	1,000,000	200,000-250,000	750,000-800,000
Thuresson, T. et al. 1999		600,000	150,000-200,000	400,000 - 450,000
National environmental action plan for Armenia, WB, 1997		700,000-1,000,000	100,000-150,000	600,000-850,000

*Note: the volume measurements are in most cases not distinguished into solid, standing volumes, or others.

**The estimate is based upon the consumption of households located in 10km length from the forests and measured in solid cubic meters. In addition to the latter the volume discovered through the detection of truck transportations is about 213,000 solid cubic meters. This implies logging of forest stock approaching 1 mln. cubic meters.

3. FUELWOOD CONSUMPTION

Renewable energy is energy derived from resources that are regenerative or for all practical purposes cannot be depleted. The use of renewable energy sources is considered to be sustainable which is relatively easy to understand in the case of solar, wind and hydro electric power. Wood is also considered to be a renewable energy resource, although the sustainability of the practice is not as simple. It is a renewable energy source in the sense that a tree cut for fuel could be replaced by a young tree that will grow in its place. This is certainly possible, but not in the case of illegal logging.

The use of wood as a fuel is not sustainable if the logging damages the site. For example, if a stand of hardwood trees were clear cut, the site could be damaged by erosion and elimination of shade to such an extent that hardwoods would not re-grow there for many generations, if ever. Sustainable forest management usually means that the site is maintained with a variety of tree species of various ages and that logging practices select only those trees that can be removed without damaging the forest ecosystem.

The use of fuelwood is also sustainable on the condition that it is converted to charcoal or other equivalents that produce heat with reasonable efficiency.

Household consumption
The household consumption is driven primarily by poverty. Wood is taken for fuel, for cooking and heating.
The fuelwood consumption level by households is affected by the following variables:
- the income level of households, i.e. the possibility to afford other heating alternatives;
- the availability of gas supplies for the households.

The fuelwood consumption has significantly decreased in the urban areas in accordance with increasing prosperity, whereas the rural areas close to the forests continue to depend heavily upon forests. However, the declining trend of fuelwood consumption is inevitable. As the forests have become remoter and harder to reach on foot, the local population gets less and less dependant upon the illegal felling activities.

Figure 1. The change in the share of gasified households in Armenia throughout 2001-2006.
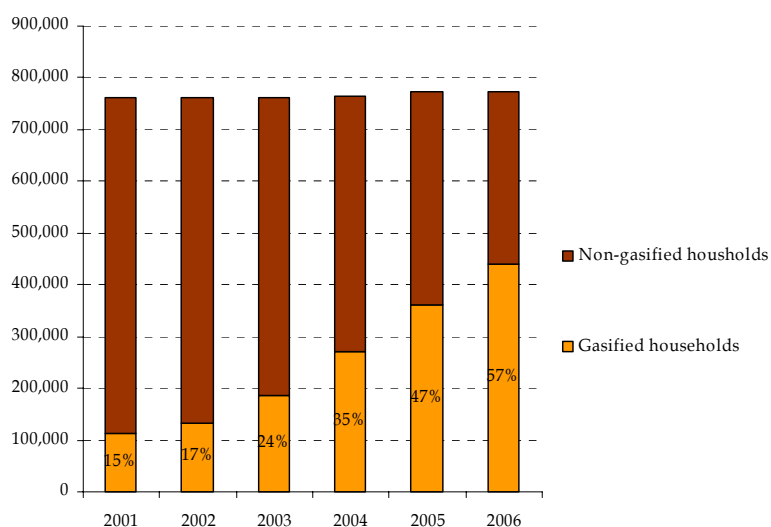
According to our estimates, about 9% of the total households were potential fuelwood consumers in 2006, either because they did not have access to gas supplies or they did not consume electricity as a primary source for heating.

The present analysis was based on the subscriber database of the "Electric Network of Armenia" CJSC, which allowed us to assess the household electricity consumption patterns for two selected seasons. The consumption rates showed that in winter seasons some 36% of the total households heat their houses mainly using electrical devices. The gas consumption rate of the households in 2006 was 55%, according to the ArmRusGasArd data. This means that 55% of the households use gas as a primary source of heating.

Figure 2. Distribution of heating sources
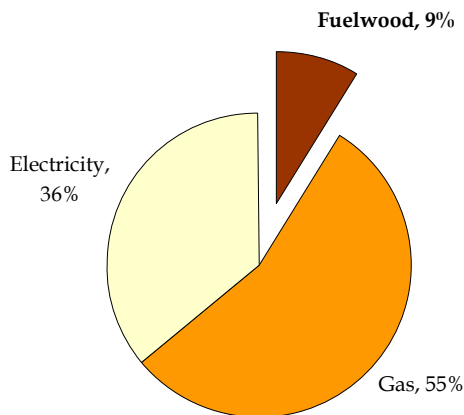
Assuming that the average fuelwood consumption rate for a household is at around 5-7 m^3 per winter season (depending on the usage of manure and residues in several rural areas the consumption is less).

The consumption of fuelwood for outdoor barbecue making by households is also widely accepted. Based on the mentioned data the overall household annual consumption volume of fuelwood is estimated to be approximately **320,000-350,000 m^3**. The fuelwood consumption has an explicitly decreasing trend during the recent years (see the table 2).

Restaurant consumption

The traditional method of barbecue making on fire is common to restaurants, as well. A study by Ter-Ghazaryan (Manuscript, 1997) shows that an average restaurant consumes about 10–12 m^3 fuelwood monthly. The total number of restaurants operating in Armenia is about 2,000, with about half of them serving barbecue as their main dish[5]. A simple calculation implies that the annual fuelwood consumption of restaurants is about 100,000-120,000 m^3.

There is an increased consumption of charcoal, which is more efficient and cost effective. The main consumers of charcoal are restaurants of relatively larger scale situated mainly in Yerevan. Our interviews with restaurant owners show that the average consumption of charcoal is about 8 tonnes annually. The amount of wood exploited is less in the case of charcoal consumption. But because charcoal consumption is not adopted widely enough and the exact numbers are not available - we cannot incorporate it into the estimates leaving the mentioned estimation the closest estimate available.

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[5] "Tourism sector research", Economy and Values Research Center, 2006

4. THE WOOD INDUSTRY

The wood processing industry is comprised of entities engaged in performing activities related to the logging, processing, production, trade and consumption of forest products.

Before the collapse of the Soviet Union the volume of imported and further processed roundwood was 800,000-850,000 m³.[6] The major part of the wood import was via the railroads. This fact illustrates the overall capacities of the wood processing industry by that time. Part of these capacities was destroyed during the crisis era, the industry structure changed significantly with numerous small organizations operating in it.

The Armenian wood processing industry is hampered by the problem of deforestation, which puts restrictions on the domestic timber supply. The main **challenges** are:

- the declining capacity to produce wood and forest products;
- the increasing demand for wood-based products, simultaneous to exports of unprocessed timber motivated by quick income opportunities.

Industry inputs

The basic input for the wood processing industry is the industrial roundwood obtained from local forests. The imported wood is mainly comprised of sawn softwood, which is mainly used in the construction business and does not serve as an input for the wood processing industry.

The observation of local timber market shows that the market prices fluctuate significantly depending on different suppliers, the qualities and the level of dryness of timber. The average market price of 1m³ oak boards varies in the range of 500-1000 USD. The price of 1 m³ beech board is in the range of 100-400 USD – depending upon the quality and dryness levels of the boards. The market prices were checked from several different sources, such as retail outlets of construction materials, as well as sole distributors of wood.

The processing entities

The wood processing enterprises vary to a large extent. Those operating in mature industries can be easily subdivided into:

- sawmills – entities mainly engaged in primary processing of harvested logs. The primary processing implies that the end products of the processing entity are primary wooden products, such as timber, veneer, mouldings, particleboard, fibre board, plywood, blockboard, engineered wood products
- entities engaged in production of secondary or value-added products of wood. The list of secondary or value-added wooden products includes furniture, parquet, barrels and boxes, coffins, doors, window frames, statues and ornaments, and other products.

The forestry industry in Armenia is hard to clearly divide into the mentioned categories as the chain of activities on forest utilization for commercial purposes is rather opaque. The entities operating in the sector vary largely both in size and capacity, as well as in the level of integration of the processing chain.

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[6] **Ter-Ghazaryan, K., V. Karapetyan and M. Barseghyan**, 1995, Forest and Forest Product Country Profile: Republic of Armenia. GENEVA Timber&Forest Study Papers. ECE/TIM/SP 8 New York:UN,

Due to the considerable amount of shadow   business undertakings in the field, the exact quantity of the operating entities is impossible to obtain. Thus, the estimate of the quantity is obtained through conducting informal surveys in 7 marzes of the country, along with using publicly available information sources (such as the "Spyur" information agency). The number of operating entities in the wood processing industry was 278, based on data only partially covering the territory of the country (the most complete information was obtained from Tavush marz). The actual number of the operating entities exceeds the mentioned number.

The industry is mainly comprised of small and medium sized companies. The areas in close proximity to the forests, mainly in Lori and Tavush marzes, are full of small wood processing workshops most often located inside the houses or in adjacent buildings. Some share of these workshops is not registered at all. The basic outputs are timber boards, parquet, plinths, furniture, doors and other joinery.

The information on production efficiency and capacity utilization is not definite. According to some observations, the wood processing entities operate throughout 10 months of the year. Other sources indicate that these entities operate sporadically, only when getting specific offers. Furthermore, due to the tightened control of the field during the recent years, many wood processing entities have ceased their operations.

The National Statistical Service indicates that the number of employees of the sector is 1916 (the figure is based on the observation of a relatively limited sample of enterprises: only 2271 operating in all the sectors of the economy). According to the latter the entities involved in the operations of preliminary wood processing subindustry are about 70 enterprises, with about 1101 employees.

The jobs of cutting, loading and transporting are not stable, and cannot have a stable number of people employed at all times. There are several "antarapetutyuns" (local forest affiliate groups) that have developed brigades from the local countrymen, whom they employ every time there is a need. The employment of these brigades has a seasonal character. The brigade for the industrial roundwood logging is usually comprised of 6 people – 4 cutters, 1 loader and 1 driver of the truck. According to our estimations there are about 1,000-1,500 people, who might be employed at certain times of the year for such kind of work.

The industry is extremely chaotic, with no stable and developed market forces. The market operates on an "ad hoc" basis, which is a major impediment to the industry development. The information complexity and asymmetry have caused an uncertainty, so that no producer can be sure that it will be possible to obtain wood on the same terms next time. The market prices of roundwood and panels fluctuate all the time, depending from the origin of the timber, the supplier's status and many other variables. According to some sector representatives, the industry is characterized by the existence of many **illegal pressures**.

The *competitive rivalry* within the industry is intense. The entities are diverse both in size and capacities, as well as in production types and markets. The companies vary in terms of processing volumes: ranging between as little as 3-4 m^3 to about 30,000-40,000 m^3 annual volumes of roundwood.

The table below presents the basic product categories produced in Armenia according to the commodity classification system of the economic activities.

Builders' joinery and carpentry of wood	Parquet and other products	Furniture	Coffins, Barrels and other cases	Miscellaneous articles of wood
• Doors and their frames, including the part of non-wood furniture • Wooden thresholds • Windows, french-windows and their frames • Surfacing Preparations for Facades, Indoor Walls, Floors, Ceilings or the Like • Builders' joinery and carpentry of wood, e.g. window-sills, internal wooden decorations, etc)	• Parquet panels, simple • Parquet panels, mosaic • Plywood • Veneer panels • Plinths • Other products	• Wooden furniture (wardrobes, tables, chairs, beds, kitchenware, etc)	• Cases, boxes, crates, drums and similar packing • Pallets, box pallets and other load boards • Casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves: Casks, barrels and hogsheads:	• wooden frames paintings, photographs, mirrors, etc • tableware and kitchenware, of wood • Tools, tool bodies, tool handles, broom or brush bodies and handles, of wood; • wooden mosaics

The basic use of timber in Armenia is directed towards the production of parquetry, plinths and internal decorations used in:

- newly built, as well as renovated apartment buildings

- newly built, as well as renovated educational and cultural establishments

- hotels, restaurants and other leisure organizations

- offices and other commercial organizations (in limited quantities).

The rapidly developing wine and brandy industries of Armenia also present large demand volumes for good quality oak timber, used as a raw material for barrel production. The conversion of the standing volume of the timber stock is implemented with the internationally accepted conversion factors.

According to expert analyses the volume of primary processed industrial roundwood used as a raw material for the wood processing industry is estimated at the range of **100,000 – 130,000 m³**. This estimate is based on the analyses of the annual decrease volumes of the forest stock, the fuelwood consumption volumes and the timber export volumes. The volume of timber, which is neither consumed as fuelwood nor exported, is considered to become a raw material for the local wood processing industry. The conversion of timber panels from the standing volume of timber stock is implemented using the conversion factors approved by the Forestry Commission of the Food and Agriculture Organization of the United Nations.

Thus, less than 20% of the total estimated logging amount is converted to wood panels for further industrial processing. According to the field expert estimates the timber costs account for about 50-60% of the total value of the end products (parquet, doors, furniture, etc.) obtained through further processing of timber.

The current state and the development outlook

The general logic underlying the wood processing industry dynamics shows that wood consumption generally increases in accordance with the economic growth. This trend is completely reversed for the fuelwood consumption, which usually tends to decrease with a country's GDP growth. There is an increasing trend of biomass energy utilization in developed countries. However, it is very different from fuelwood consumption driven mostly by poverty. The key trigger for the biomass energy utilization is its ecologically sustainable nature and the fact that it is deliberately comprised of residues of the wood processing industry.

Based on Armenia's economic growth rates, consumption and production of forest products is expected to show a stable growth in the long-term prospective. Despite that, the developments in the short-term perspective imply a gradually declining nature of the wood products consumption. Wooden products have become relatively less important mainly due to the comparatively low prices, high quality and abundance of substitute products in the market. The declining trend is true for the fuelwood as well; however, the driving forces are different. The gradually developing infrastructure for providing access to gas supplies to households all over the country is a major stimulating force for lessening the fuelwood consumption. Gas is notably cheaper and is easy to use, and this makes it more attractive for the households. A major impediment is the amount of initial installment, which is higher than a low-income household can afford. However, the rate of fuelwood consumption will surely decrease, and not only due to the gradually decreasing poverty rates, but also because forests are becoming physically hard to reach.

The fact that forests have become hard to reach has a major impact on the current trends of the wood processing industry as well. This makes the illegal logging activities more and more costly and requires more and more resources both in terms of real resources and power on state bodies. Thus, wood is increasingly harder to obtain for small and medium-sized businesses and sole proprietors.

It is logical that the domestic consumption and production of parquet, doors and furniture are highly correlated to the growth rates of the construction industry besides the income levels, and will continue to grow with the rates congruent with the construction growth.

Construction industry is currently the fastest growing sector of the country's economy. It constituted the 26,7% of GDP in 2006 and surpasses other sectors of the economy in value added creation terms (it exceeds the same figure of its successor sector – agriculture, by about 1,5 times). According to the official statistics, the construction volume in 2006 was about 1,5 bln USD, about threefold exceeding the GDP growth rate of the year. Due to the complications in accounting for the apartment constructions, the figure included in the official statistics illustrates the reality only partially. In addition, the shadow economy accounts for about 30-50% of the total, according to different estimations. The total real construction volume can be estimated at around 2 bln USD.

The following figure clearly outlines that the volume of increase of timber import in 2001-2006 did not match construction growth rates. This fact reinforces the thesis according to which the growing timber demand fuelled by the construction growth is yet satisfied through the local timber stock.

Figure 3. The dynamics of construction volumes and the wood imports to Armenia throughout 2001-2006
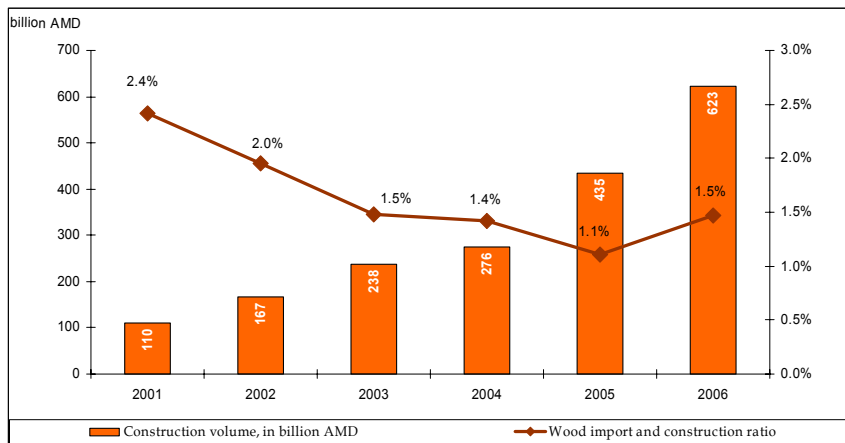
Source: National Statistical Service of RA

It is noteworthy that the restoration of the ferry communication means fostered the wood imports to the country by reducing the related transportation costs. The retainment of this trend can efficiently enhance the substitution of the local timber consumption by the imports.

The following table provides estimates on how increasing incomes may lead to changes in the demands of households. As incomes rise, households will move up the hierarchy towards a pattern of demand that will focus more on higher needs. Thus, for example, there will be more demand for fashionable, well-designed forest products with a greater range of choice, and consumers will focus less on price in their purchasing decisions. A wealthier society will also place greater emphasis on forest services (such as conservation and recreation) relative to the production of forest products; and, in product markets, consumers will have a greater interest in the environmental credentials of those products.

At the highest levels, there will also be more interest in organized and educational recreational activities, and individuals are more likely to take an active interest in forestry affairs.

The consumption patterns in many of the developed countries are already focused on the higher needs. However, Armenia is starting at a lower position in this hierarchy, but will move up over the next 20 years, depending upon how rapidly the economy will grow.

Table 3. Relationship between the hierarchy of human needs and demands placed on the forest sector

Order	Human need	Demands placed on the forest sector
Basic	Food , heat	Using wood for heating and cooking purposes and harvesting of food (plants and animals) from the forest out of necessity. Still very relevant for Armenian rural households. Will decline parallel to gasification rates.
Basic	Shelter	Demand for basic construction materials (sawn wood and wood-based panels). Still very important for Armenia; will increase as the construction industry is expected to grow with the current high rates at least for 5 years.
Low	Possessions	Demand for wooden furniture, packaging materials and other articles. Still very important for Armenia, the demand will grow, as the income levels rise.
Medium	Personal development	Demand for improved health, leisure and recreation. Important in more developed countries. This is expressed as a higher demand form for forest recreation, including NWFP collection as a leisure activity. Greater interest in protecting the environment (for health reasons). Still does not exist in

Order	Human need	Demands placed on the forest sector
		Armenia, will take shape in Armenia in the mid- to long-term perspective.
High	Knowledge	Interest in learning about the forest environment (e.g. through organized recreation activities). Will take shape in Armenia in the mid- to long-term perspective.
Very high	Self-awareness	Demand for high-quality forest products with a greater focus on fashion and design. Greater interest in active participation in forestry affairs. Demand for environmental improvement for altruistic reasons. Still does not exist in Armenia. Will take shape in Armenia in the mid- to long-term perspective.

The household income levels have increased twofold during the last two years, although the overall income levels are still low along with an excessive income gap. Thus, in spite of the overall low household income levels, certain demand by high income segments of population exists for high end products, including the wood-made products.

Figure 4. The dynamics of household income levels during 2001-2006
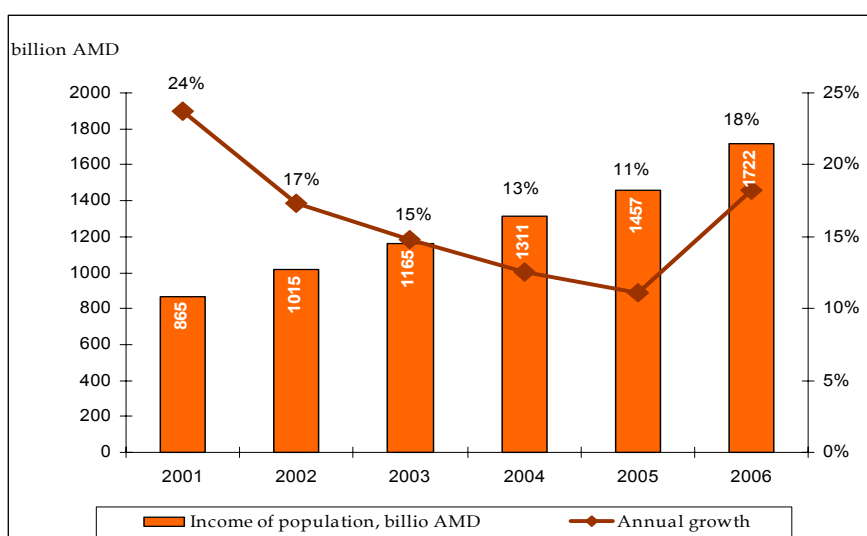
Source: National Statistical Service of RA

Only the improvements in processing technology and recycling will lead to a sustainable forest sector. High-quality products thus can be produced from much lower inputs of raw wood. The current trends towards globalization, competition from low-cost substitutes and greater demands placed on the sector are likely to continue in the future. However, it is expected that the sector will rise to meet these challenges, as it has done in the developed countries.

Substitute products

The domestic markets for the substitutes to wooden products are increasingly becoming more competitive than the wood industry products themselves. This trend is not characteristic to international markets where the demand for wood products is forecasted to have strong growth rates.

A smallest office desk made from laminate boards costs about 45,000 AMD, while its wooden equivalent costs 120,000AMD. The price difference implies that middle class consumers cannot generally afford wood.

According to the household survey[7] conducted the annual expenses on furniture amount to about 200,000 AMD; the expenses are, however, rather occasional.

Table 4. Comparison of prices of wooden products and the equivalent substitutes; AMD

	Wooden product	**Substitute**
	Parquet	**Laminate, other plastic covers**
Price per 1 m²	3,000-3,500 (beech) 6,000-8,000 (oak) + Installment costs of about 5,000-20,000	7,500 – 15,000 including installment costs
	Wooden windows	**The so called "EuroWindows" of metal plastics**
Price per 1 m²	~60,000	20,000-40,000
	Wooden furniture (average size office table – 120cmX90cm)	**Laminated equivalent** (average size office table 120cmX90cm)
	100,000 - 120,000	35,000 – 45,000

4.1 The supply chain of the wood processing industry

By definition, tracking and measuring illegal logging and/or illegal trade in forest products is more art than science. The boundary between legal and illegal practices is unclear. Wood is usually procured from many different sources and methods.

A simple model of a wood supply chain begins with the felling of trees in a forest, the logs then going to processing stages of different complexities.

The following figure represents a wood supply chain showing the various stages in a typical process. Left boxes represent processing operations; right boxes describe the movement of the material between processing stages.

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[7] CRRC-Armenia Data Initiative survey, 2006. Though the survey is not representative.

Figure 5. The wood supply chain

Forests	**Phase 1 – Getting the permits**	Valid permits can only be obtained from Hayantar authorities, due to state ownership of forests.
	Phase 2 - Logging	This is the core phase from the perspective of illegal forest activity risks. Each licensee must implement the harvest in specific sites and specific
Sawmills	**Phase 3 – Transporting**	Road police must control log transportation. The illegal logs are generally transported in conjunction with the legal volumes.
Further processing entities	**Phase 4 – Processing**	The legal and illegal timber is easily mixed at processing enterprises. As logs do not have any identifying labels, it is impossible to recognize their origin.
Local end users and export	**Phase 5 – Exports**	Timber crosses the state border directly on trucks. There are no sufficient methods of assessing the timber origin.

The main driving force for the exports is the profitable opportunity of selling this timber abroad, particularly to Iran. The share of unprocessed roundwood in total exports is notably large. In some cases, Iranian traders drive directly to logging sites and buy timber there. The high prices of roundwood in international markets make its exports an extremely profitable venture, and this trend is most likely to maintain in the future as well.

4.2 The cost gap

The wide gap in cost between legitimate, legally procured timber and illegal timber provides additional incentives for illegal logging.

A considerable cost difference was observed between the legal and illegal timber procurement processes. In particular, the cost difference of 1 m3 unprocessed timber procurement might be as much as 50,000-70,000 AMD, which is a significant financial incentive for illegal logging. The legal procurement process is the acquisition of timber from Hayantar with predefined prices, along with the transportation costs. The illegal procurement costs are comprised of several successive processes and costs including arrangement with tree cutters and loaders, the transportation of the wood, etc.

Figure 6. The cost breakdown of unprocessed oak timber procurement practices, AMD

Illegal procurement

80,000 (20m³ * 4,000)	**10,000** (20m³ * 500)	**30,000** (20m³ * 1,500)	**10,000**	**20,000**	Total costs **150,000** AMD
Payment to the tree cutters	Payment to the loaders	Payment to the truck driver	Fuel costs per truck	Additional costs	Cost per 1m³ **7,500**

Note: the provided figures are average costs, which can vary depending on specific circumstances. Additional costs include bribes and other facilitating fees.

Legal

72,000 – state-enforced price per 1m³ of oak industrial roundwood	**500** – transportation costs (the cost per truck (20 m³) is about 10,000)	Cost per 1m³ **72,500**

4.3 The exports

Since Armenia possesses unique forests, its diversified resources have high prices in international markets. This strong export demand has placed further pressure on the already limited forest resources.

The following table shows the official data on exports of wood and articles made of wood.

Table 5. The official statistical data on exports of wood and wood articles

	2005		2004		2003		2002		2001	
	m³	$	m³	$	m³	$	m³	$	m³	$
Total	**7,914**	**961,624**	**11,750**	**1,496,150**	**11,101**	**1,676,618**	**8,109**	**1,282,060**	**3,798**	**848,404**
Timber	5,980	587,826	10,496	966,404	6,142	818,255	3,819	671,700	2,467	441,453
Logs	1,642	235,361	728	68,919	4,349	291,377	3,597	113,800	804	61,732
Veneer	94	40,077	133	75,661	306	158,125	405	173,000	187	90,637
Joinery	67	44,404	178	260,809	82	57,421	43	15,600	309	204,690
Particle board	41	1,175	0	0	0	0	0		20	2,125
Mouldings	38	1,700	108	51,313	0	0	0		0	307
Fuelwood	29	8,675	0	0	0	0	0	0	0	
Casks and barrels	22	25,657	43	41,048	195	336,545	242	289,400	9	36,878
Other articles from wood	1	2,341	0	249	0	100	0	60	2	8,625
Wooden statues and ornaments	1	5,807	1	14,427	1	12,147	2	11,900	0	1,800
Packaging	0	160	0	820	27	2,648	0	100	0	44
Tools	0	100	0	0	0	0	0		0	0
Tableware	0	1,095	0	0	0	0	0	5,800	0	0
Sleepers	0	0	64	16,500	0	0	0	0	0	0
Fibre board	0	0	0	0	0	0	0		0	113
Wooden frames	0	0	0	0	0	0	0	700	0	0

According to the official statistics more than 5 thousand tons of wood was exported from the country in 2005. About 92% of this volume was registered as unprocessed or primary processed wood.

The recorded amounts of exports have been cross-checked against the amount of product recorded as imported by those countries from Armenia (that is, Armenia's export records have been compared with other countries' import records) via the international trade database of the UN Comtrade. The following table illustrates the main findings.

Table 6. Comparison of exports data of wood products (excluding furniture) to selected countries from the sources of National Statistical Service of RA (Armstat) and UN Comtrade, USD

Country	2003		2004		2005	
	NSS	Comtrade	NSS	Comtrade	NSS	Comtrade
Total	1,340,200	1,311,695	1,213,600	1,672,337	920,800	2,686,085
Iran	802,100	822,416	962,200	1,331,343	758,600	1,252,437
Czechia	0	0	0	0	91,400	718,859
Russia	240,400	259,179	105,200	143,833	18,200	231,754
USA	7,200	4,725	47,800	53,349	11,200	161,807

Country	2003		2004		2005	
	NSS	Comtrade	NSS	Comtrade	NSS	Comtrade
Spain	33,400	57,999	18,900	68,498	0	128,379
France	221,700	167,376	46,000	75,314	41,000	126,954
Georgia	11,800	0	4,000	0	400	0
Turkey	23,600	0	29,500	0	0	0
Greece	0	0	0	0	0	37,453
Malaysia	0	0	0	0	0	28,442

In comparing the NSS and UN data the difference between the FOB values and CIF values are not neutralized. However, in case of several countries the difference cannot be explained with this factor, even if considering the average estimated transportation costs.

A more complete analysis of export by separate countries would be possible provided the more detailed information sources on separate product groups and physical volumes thereof. However, this data is not available in consistent units of measurement from two sources.

The average export price was approximately 150 USD per 1 m³ of wood and article of wood. The annual export volume was estimated at around 10,000-12,000 m³.

Figure 7. The wood exports from Armenia according to UN Comtrade data, USD
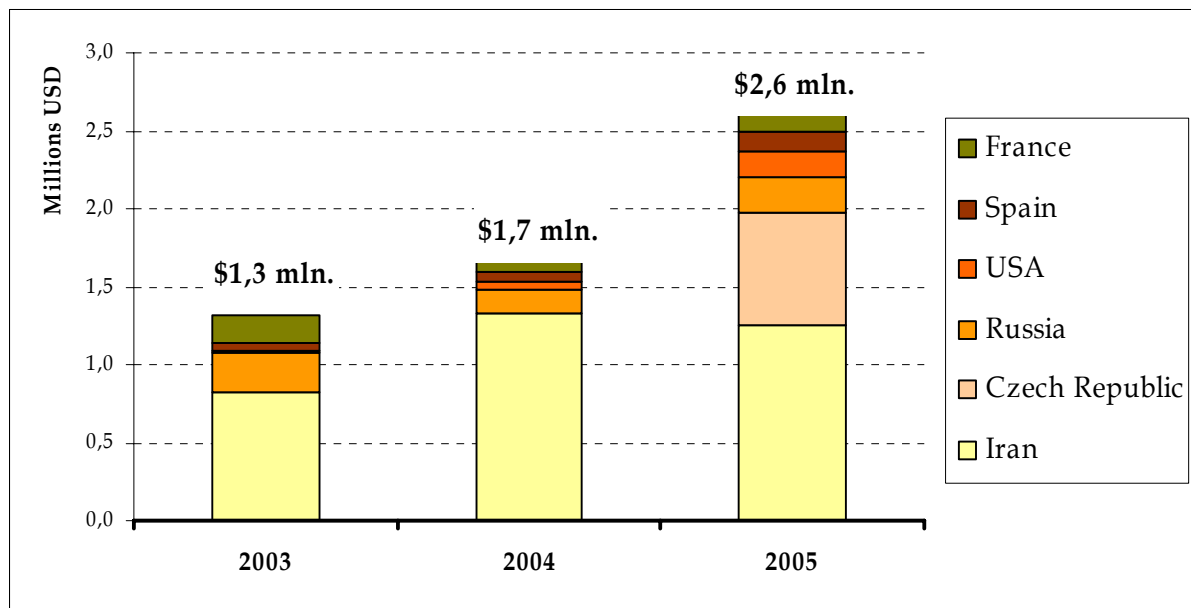
The export of unprocessed timber is fuelled by the considerable international demand for it along with high prices. The demand forecasts are yet to remain. The main export destination is Iran where the industrial roundwood goes through additional processing or is transported to other countries. The export of non-processed wood is a cause for significant lost income for Armenia.

5. THE FOREST RESOURCES

Armenia's current forest cover is estimated to be approximately one fifth of the forest cover 4000-6000 years ago. Given the current economic, social and political conditions in the country, this decline is likely to continue although with lower rates. This poses a serious threat to the long-term sustainable development of the country. In the early 1990s, according to the last nationwide National Forest Inventory of 1986-1988 and Forest resources accounting in 1993, the forest cover constituted 11,2 % (334,100 ha) of the national territory.

The north-eastern and south-eastern parts of the country, and the eastern shores of Lake Sevan have naturally the most favorable climatic and environmental conditions for the growth of forests. Today, 62% of the forest cover is found in the northeast, 36% in the southeast, and only 2% in the central region of the country. About 70% of the forest area in 1991 was reported to consist of *high forest*, where indigenous beech, oak and hornbeam were the dominating tree species. The remainder was comprised of *coppice forest* (22%) and *shrub forest* (7%).

The Republic of Armenia is a low forest cover country with 0,1 ha forest covered area per inhabitant on average, correspondingly. The forested area per CIS inhabitant is 2,7 ha and the world mean is 0,5-0,8 ha.

In total forest resources, the shares of main tree species are:

- Beech – 20,68 mln. m^3,

- Oak – 12,5 mln. m^3 ,

- Hornbeam – 6,0 mln. m^3 ,

- Other tree species– 2,56 mln. m^3.

Figure 8. The forest estate of Armenia (as of 1993)
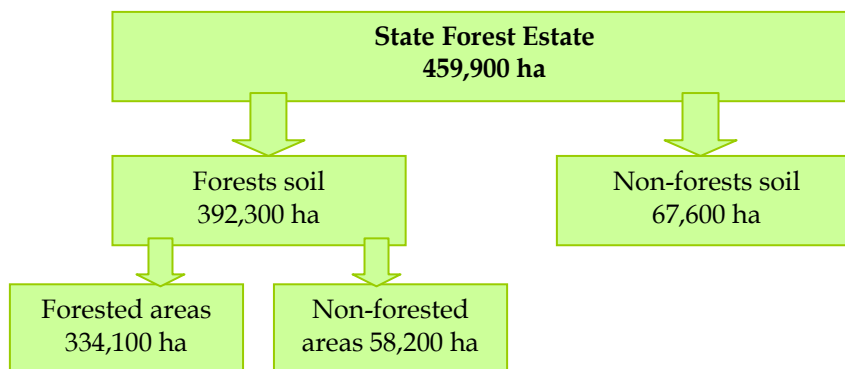
- Artificial plantings – 36,900 ha
- Canopy unclosed plantings – 13,400 ha
- Forest nurseries – 300 ha
- Scarce forest areas–1,900 ha
- Arable land – 1,100 ha
- Hay-making area – 5,800 ha
- Pasture lands – 29,900 ha
- Water surface – 500 ha
- Vineyards and fruit orchards – 2,900 ha
- Roads – 700 ha
- Settlements – 2,800 ha
- Sandy areas – 600 ha
- Other land-uses – 23,300 ha
- Non-Wood Forest Products – 700 t (pear), 150 t (apple), 600 t (cornelian cherry), 60 t (nut)-north-eastern Armenia

The forest soil in Armenia is the grey forest soil, whereas in Russian taiga its "podzol" soil. The vegetation succession (steppe zone invaded into forest soil areas), human impact and

deforestation have significant impact on the   forest soil, which could be seen in future as potential for areas for reforestation.

Forests in Armenia are distinguished with their rich species structure. More than 260 tree and shrub species grow in Armenia: 5 oak species (*Quercus*), 2 ash species (*Fraxinus*), 2 linden species (*Tilia*), 2 hornbeam species (*Carpinus*), elm (*Ulmus*), several pear species (*Pyrus*), several sorbus species, 5 juniper species (*Juniperus*), etc. Also, such relict tree species as yew (*Taxus Bacata*), hazelnut (*Corylus colurna*), walnut (*Juglans regia*) grow here. The main forest forming tree species are oak (*Q.macranthera, Q. araxina, Q. iberica*), Eastern beach (*Fagus orientalis*) and Caucasian hornbeam (*Carpinus Caucasica*), which form not only pure stands, but also mixed and complex oak/beach/hornbeam stands (Grigoryan, A.A. 1979; Grigoryan, R.A.1974; Vardanyan, Zh.H. 2003).

6. THE FOREST POLICY AND LEGISLATION

The National Forest Policy and National Forest Strategy documents proclaim that, "The main goal of the national forest policy for the Republic of Armenia is provision of sustainable management of forests and forest-lands. The task for the government of the Republic of Armenia is to make balance between nature protection and public interests, by creating conditions for the country development, keeping at the same time ecologic and social values of forests".

The main goals are outlined below:

- Reforestation, development of useful features of forests and sustainable forest management,

- Institutional improvements and capacity building for sustainable forest utilization, as well as establishment of forest conservation and protection services, seed, nursery and hunting farms, education and training centers and networks,

- Creation of scientifically proved, sustainable forest management plans and practices (short and long-term),

- Ensuring sustainable utilization of non-wood forest products,

- Improvement of sustainable forest management legislative bases, including scientifically proved mechanisms (methodology, criteria, etc.), which take into account international experience.

It is recognized that the current legislation and management system do not allow to properly investigate neither the exact volumes of illegal logging nor the responsibility.

The government related factors of illegal loggings are:

- The insufficient capacity of Hayantar, i.e. lack of corresponding infrastructures (e.g. the total length of forest roads in Armenia is 325 km) and professional foresters, particularly in the field of forestry economics,

- The wood selling methods, which do not support development of free and fair market relations,

- The inadequate mechanization level of forest activities and the almost empty technical, material and transportation park,

- The poor financial condition of Hayantar (despite that, it is included in the list of the biggest taxpayers of Armenia),

- The limited use of modern forest inventory systems,

- Insufficient utilization of international financial aid, e.g. since 1993, FAO, the WB, SIDA, the Government of Japan and other sources provided millions of dollars to the sector, for institutional improvements and capacity buildings. These projects could have resulted in more significant effects.

- The absence of sufficient information on timber and non-wood forest product markets,

- The absence of appropriate forest management plans, which will provide sustainable forest management practices,

The causes of illegal logging outlined in the newly adopted forest policy are as follows:

- Low salary of Hayantar employees,

- The absence of economic, legislative and other mechanisms/tools to prevent illegal forest utilization,

- The absence of mechanisms/systems to measure illegal logging damages (damages to state, public, economy and environment),

- The ineffective system of recording the illegal forest utilization and enforcing the state regulations,

- Absence of proper economic control,

- The uncoordinated activities of local communities and forest enterprises to confront the illegal logging practice,

- The unsatisfactory level of awareness and information on the illegal forest utilization sizes and practices,

- The low level of material and technical promotion system,

- The low level of local timber prices in comparison with international prices.

More attention to forest management issues should be granted by state anti-corruption programs.

In the new forest policy, special attention and importance is given to community forestry issues. WB NRMPRP program includes activities to promote community based forest management in Armenia. The forests around two communities in northern Armenia will be allocated to them through Hayantar to test the effectiveness of community forestry in the country. However, the poverty rates in local communities are still high making the local households dependent on the forest resources to overcome energetic and survival difficulties.

Thus, high prices on energy consumables drive householders to harvest fuelwood from surrounding forests. The harvesting volumes usually exceed the allowable levels and threaten the environment. Beside fuelwood harvest, the local households utilize NWFP heavily, especially berries, mushrooms, hay-making, pastures, bee keeping, pig breeding practices, etc.

Hayantar monitors the illegal activities in the forest sector through the reports on field surveys implemented by the forestry protection staff on biannual basis. The Inspectorate also controls the sector and some preliminary results are available. Forest protection staff patrol their areas on a routine basis to check the legality of all felling, hunting, grazing and hay-making. Any violations are reported through an official protocol procedure. For each offence a protocol is prepared and a legal fee, threefold the official fee for permit acquisition, is enforced. Otherwise, the case is sent to the court.

7. CONCLUSIONS AND PROPOSED SOLUTIONS

The current dynamics of forest degradation will cause the loss of valuable and genetically fine species of oak, beech, maple, ash, etc. The valuable forest stands will be transformed into low-value coppice stands. The ruined forest lands will provide pasture-lands or hay-making areas physically decreasing the forest cover and causing further natural hazards – landslides, erosion, mudflows, avalanches, etc. – that will accelerate and enlarge their geographical distribution.

The good news is that contrary to the widespread opinion, the Armenian forests will not completely disappear, as almost 30% of the forest cover has a hard-to-reach location, making the logging costs high even for the illegal practices. The increasingly stricter state policy further enhances the likelihood of positive developments of the forest sector in the country.

However, in order to maintain the economic and environmental importance of Armenian forests, an elaborate conservation plan should be adopted. The forest sector is currently focused on wood processing, while the scarcity of domestic wood supply presents a great challenge for the sector.

While the demand for fuelwood consumption is expected to decrease in the mid-term perspective, the commercial wood industry will grow. The high growth rates of the construction industry, as well as the substantially rising income levels, will increase the level of wood logging. Therefore, there is a clear need for a comprehensive action plan to prevent the expected negative developments.

Recommended actions for decreasing the fuelwood consumption

1. Promote the demand for gas supply

Gas is a considerably cheaper and more efficient source of energy supply. One of the major impediments to gas consumption advancement is the insufficient state of infrastructure and the high initial installment costs. The total costs that reach up to 120,000 AMD are comprised of the purchase price of a gas meter (40,000 AMD which are then reimbursed a year after the installation by ArmRusGasArd; this is actually a one year interest-free loan by households to ArmRusGasArd) and the costs for pipes (which the households obtain individually).

As the gas meter costs are actually included in the tariffs of gas supply, the initial installment charges are unfairly imposed on the households. The Public Services Regulatory Commission, which has the power to control the tariffs of ArmRusGasArd, can further research the problem and make a decision more favorable to the households rather than the mentioned company.

The second part of the costs should be eased for the public by facilitating access to especially designed micro credits with low interest rates.

Recommended responsible agents	Recommended actions
The Public Services Regulatory Commission	Revise the tariff and initial costing system of ArmRusGasArd; consider removing the initial gas meter cost burden from the households
Environmental public advocacy groups, local banks, micro credit organizations	Organize micro credit fund management through local banks

2. Promote the more efficient use of wood and residues

The efficiency of the wood as energy source can be enhanced by combining it with different raw materials. This practice is highly accepted in rural areas, where manure is extensively used in combination with wood. As this cannot be introduced in urban areas, a more innovative approach of fuel brick production from wood residues should be considered.

The consumption of charcoal in restaurants can be promoted as a more efficient alternative to fuelwood.
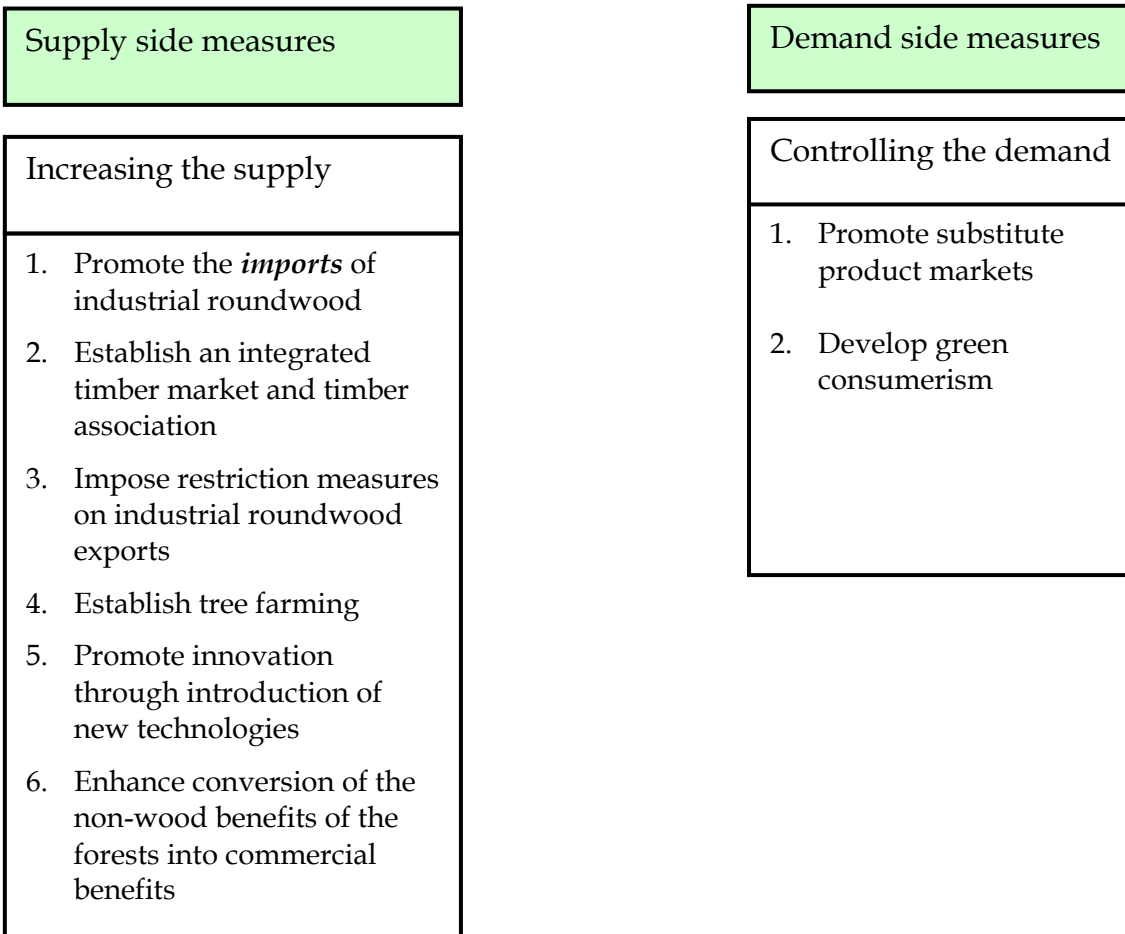
Recommended responsible agents	Recommended actions
Private investors, environmental advocacy groups	Promote the production of efficient energy sources such as wood residue bricks, which can be by-products of the main timber production entities.

Recommended actions for decreasing the consumption of domestic wood for commercial purposes

The actions can be divided into two broad categories labeled "Market measures" and "Administrative measures".

Market measures
Market measures are based on the influence of supply, demand and consequently the price of the commercial wood.

Supply side measures

Demand side measures

Increasing the supply

1. Promote the *imports* of industrial roundwood

2. Establish an integrated timber market and timber association

3. Impose restriction measures on industrial roundwood exports

4. Establish tree farming

5. Promote innovation through introduction of new technologies

6. Enhance conversion of the non-wood benefits of the forests into commercial benefits

Controlling the demand

1. Promote substitute product markets

2. Develop green consumerism

Supply side measures

1. Promote the industrial roundwood imports

The main option for retaining the available capacity of wood processing is facilitation of imports. The most visible method of imports promotion is the VAT extraction, which will bring the imported timber costs down by 20%. The imported wood prices will still be considerably high compared to the local costs of timber[8]. However, with the success of administrative measures of controlling illegal logging, the imports will become the most important source of supply for the wood industry. The CIF price for 1 m³ unprocessed industrial hardwood imported from Russia is approximately $425-475.

Recommended responsible agents	Recommended actions
Largest players in the wood processing industry facilitated by the state bodies (Ministries of Agriculture (MoA), Nature Protection (MNP), Trade and Economic development (MTED)	Conduct a profound analysis of the Russian timber market and promote the establishment of business relationships between the business stakeholders.
Government, National Assembly	Amendment to the Law on VAT, exemption of wood import from VAT

2. Establish an integrated timber market and timber association

Most wood processing companies are small and medium-sized enterprises with little communication between themselves. This is a great disadvantage in their deals with international timber suppliers, and will cause them to accept lower quality wood at higher prices, as the balance of power in the trade relationship is usually weighted towards the larger companies. The association will create economies of scale by unifying the purchasing power of the relatively small-sized domestic companies.

The specialized association will standardize the importing transactions and establish timber logistics companies with facilities such as special transportation systems, workshops, equipment, offices, and a full-time staff. This will ensure coordinated and smooth purchases, storage and shipping, a special location for business transactions. With close collaboration with Russian or other international timber markets, timber price, quantity and other market information can be publicized to ease the access for the domestic wood processing companies.

The small scale companies also have difficulties in accurately assessing the domestic demand, which will cause them to over or under stock. The trade association will facilitate information sharing on domestic demand and supply sources and prices, thus enhancing the productivity of raw material usage.

The association could also provide industry specific services such as technical and business consultancy to SME's.

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[8] Considering Russia as the most appropriate partner country for roundwood imports - the average price of 1m³ oak roundwood at is about $325, while the domestic price is about $200 (http://www.sbn.finance.ru, www. wood.ru)

Recommended responsible agents	Recommended actions
Key wood processing companies, Environmental NGO's	Establish a timber association
Small and Medium Enterprise Development National Center (SME DNC)	Provide sector specific support to the companies for increasing their operative effectiveness through consulting, training and other services
Donor organizations	Capacity building and assisting in organizational development of the Association

3. Impose restriction measures on industrial roundwood exports

The volume of industrial roundwood legal harvest is NOT sufficient to export without adding value to it, thus a ban on unprocessed timber should be introduced.

Recommended responsible agents	Recommended actions
The Government of Armenia, National Assembly MTED	Make respective legislative amendments to the Customs Code of the RA, introduce a ban on unprocessed timber Arrange the issue with the WTO

4. Establish tree farms

What is it?

The term "tree farming" was first used in the 1940s to introduce the public to sustainable forestry terminology they could easily understand. A tree farm is generally defined as an area of privately owned forestland dedicated to the growing of new forest crops for commercial purposes, protected and managed for continuous production of forest products. Farming implies continual stewardship and production of goods year after year. By linking the term "farming" to trees, foresters could communicate the concept of sustainable production of forest products over time. Tree farming implies commitment to the land and was the philosophical opposite of the "cut-out and get-out" philosophy of the early 20th century.

Tree farms are more than artificial plantations, e.g. pine plantations or Christmas tree farms. Tree farms are varied in nature and contain many different habitats and stages of forest regeneration, from seedlings to mature timber. Biodiversity is a critical component of a certified "tree farm". Tree farmers must maintain natural forest buffers and other aspects of conservation techniques.

American Tree Farming System (ATFS) was established in response to concerns that America's private forests were being cut at unsustainable rates without reforestation. It all began in 1941 when the first Tree farm was designed in Washington State. The Tree farm's purpose was to demonstrate sound forest management practices to area landowners. California's Tree Farm program started later in 1941 and has grown to include nearly 600 tree farms covering 1,4 million ha of the state.

Implementation of the "tree farming" (TF) concept in Armenia could serve as a solution to mitigate deforestation and unregulated forest cuttings in Armenia.

Tree farming in many senses is equal to the "sustainable forestry" (SF) concept, which means "the management of forests to meet the needs of the present without compromising the

ability of future generations to meet their own needs by practicing a land stewardship ethic which integrates the reforestation, managing, growing, nurturing and harvesting of trees for useful products with the conservation of soil, air and water quality, wildlife and fish habitat and aesthetics." The main difference between TF and SF is the biodiversity issue, which is more stressed in the SF concept than in TF concept.

The costs of establishing 1 ha of a tree farm are around $1,000 (the expert estimate of "Armenian Forests" NGO). In case the annual volume of tree planting reaches the annual deforestation rate at 2,500 ha (which, however, will not restore the deforestation damage as, e.g. oak needs 100-150 years to grow), the initial annual investment needs will equal to $2,5 mln. As the payback for the tree farming engagement is a long period with not enough short term benefits – the initiative must be backed by public funds. If the official price for industrial roundwood goes up to $250 given the current official harvesting rates, the revenue from the legal fees will provide the equal amount of financial revenues to undertake the reforestation of 2,500 ha.

An intensive tree farming/reforestation project can also be implemented within the framework of the Kyoto Protocol[9] Clean Development Mechanism initiative. The **Clean Development Mechanism** (**CDM**) is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment (the so-called Annex 1 countries) to invest in emission reducing projects in developing countries as an alternative to what is generally considered more costly emission reductions in their own countries.

Planting new forests to absorb excess CO_2 in the atmosphere is an option that can be considered in the context of harnessing forests for curbing climate change. The idea of carbon offset plantings, originally proposed by Dyson (1977) was implemented under the United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol in 1997. Besides planting productive or protective forests, agro forestry systems or urban forests, an entire palette of silvicultural and management options exists for enhancing CO_2 uptake and storage in forest ecosystems: restoring degraded forests, enrichment of plantings, extending rotations in even-aged forests, light thinning, favoring species with high sequestration rates, under-planting open forests, and fertilizing or irrigating stands.

Outside the forest, wood products can store carbon for decades and even centuries. In industrialized countries, the carbon pool in wood products amounts to 20 to 40 tonnes of carbon per hectare for the forest area. Under certain circumstances, managed forests and their products may store more carbon than unmanaged, natural forests.

The tree farming/reforestation project can be based on public works. The project needs to be fueled with the Diasporan or other private investment sources, as the government spending will not be adequate for the project. The process will, however, require responsible management, and will need to be implemented and closely monitored by centralized state authorities.

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[9] According to the Kyoto Protocol, developed countries and countries with economies in transition shall promote sustainable forest management practices, renewable forms of energy, reforestation, and they must adopt national policies and take corresponding measures on the mitigation of climate change by enhancing greenhouse gas sinks and reservoirs.

According to the Kyoto Protocol, developed countries and countries with economies in transition could use Joint Implementation Mechanism, i.e. they may jointly carry out greenhouse gas offset projects involving reforestation or forest management. Some or all of the greenhouse gas offsets achieved in the host country's forests are transferred to the investor country on the basis of contractual arrangements between the partners.

Credit prices have reached more than $100 per tonne of carbon in EU emission trading (the only existing international market for trading greenhouse gas emissions), the price of credits from reforestation project is currently as low as $ 10-$15 per tonne of carbon because of perceived risks to buyers.

> **Deforestation in Armenia and Armenian forests' capacity to sequestrate CO_2**
> According to calculations (Gabrielyan V. & Tsarukyan M., 1999), Armenian forests each year accumulate more CO_2 than they emit. In 1985-1990 CO_2 accumulation was 9-10 times higher than CO_2 emissions, but in 1994-1996 and following years, due to unregulated and illegal forest utilization and cuttings, the relation of CO_2 accumulation and emission became 1,04-3,08.
> The coefficient of C content in Armenian forests is calculated to be 0,496. The biomass of Armenian forests in 1990 was 383,73 thousand tonnes, and C content, taking into account 0,496 coefficients was 190,13 thousand tonnes and in 1996 356,89 thousand tonnes and 177,01 thousand tonnes, correspondingly.
> Thus, during 1992/93-2006 at least 8-10 mln. m^3 wood has been removed from Armenian forests, which means around 5,600-7,000 tonnes of biomass and 2,777, 6-3472 tonnes of carbon.

Recommended responsible agents	Recommended actions
MNP, MoA, Environmental NGOs, Diaspora donors,other investors	Design a reforestation project according to the CDM requirements.
Local communities	Manage and develop tree-farming activities using the CDM funds, if available.

5. Promote product and process innovation through introduction of new technologies

Recycling
Properly designed policy and standards can trigger innovations allowing the companies to use the scarce raw materials more productively and ultimately lowering the volume of timber usage per unit of a product, as well as finding new and innovative solutions to the problem of domestic timber supply scarcity.

In environmental terms, forest products have a distinct advantage in that they can be recycled relatively easily. At present, about 60% of the European wood used to manufacture forest products comes from trees and the remainder comes from recycled wood and fiber. This trend towards a greater use of recycled material has been partly driven by market forces, and more importantly, the environmental legislation that has encouraged consumers to recycle waste and required producers to use recycled materials. A more recent development has been the imposition of stricter waste controls and landfill taxes that have further increased the incentives to recycle products.

Renewable energy
One of the innovative developments is the production and use of renewable energy from wood residues.
As the manufacturing of forest products requires a relatively low level of energy use, the wood processing companies themselves can be major consumers of the renewable energy produced. Production of wood residue bricks should be enhanced by tax incentives for both the producers and consumers. There is an established capacity in Armenia for the renewable energy technology production (brick making production lines)[10], which gives the starting point for the sector development. The further development will entail the establishment of short-rotation tree farms especially designated for fuelwood production.

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[10] "Suren Technology" LLC that operates in "Andron" science research institute/technopark has the know-how of developing brick making production lines. It has already exported a production line to Italy. (*Source*: the official web-site of the Small and Medium Entrepreneurship Development National Center of Armenia).

Waste management – a driving force to developing the sector?

With increasing concerns about waste and the environment, many countries are continuing to introduce measures to reduce waste and encourage recycling. In particular, the EU has passed several regulations and directives on this subject since the early 1990s. The overall EU policy on reducing waste establishes a hierarchy of waste management, which prioritizes prevention of waste followed by its re-use and recycling, and finally, its disposal through energy recovery.

Policy instruments that have been used by countries include: stricter laws governing how and where waste can be disposed; compulsory packaging return programs; subsidized waste recovery and sorting schemes; compulsory domestic waste separation requirements; and landfill taxes. These measures have been in place for many years now in some countries but one in particular - landfill taxes - has been very effective at encouraging recycling.

Landfill taxes provide a very strong incentive to recycle, as they impose a direct cost on industry that varies in relation to how much waste is produced and has to go to landfill. Furthermore, landfill taxes can be continually updated and increased to constantly raise performance in the area of waste control and waste management. Some sources have estimated that waste disposal costs could amount to between 5 percent and 10 percent of turnover in major timber using sectors.

Recommended responsible agents	Recommended actions
MNP, MTED, Private Investors	Conduct research on recycling opportunities and relative technological needs. Introduce incentives for investments in new technologies.
Wood Processing Association, Environmental NGOs	Educate businesses on new technologies and methods of wood processing

6. *Enhance conversion of the non-wood benefits of forests into commercial benefits*

The importance of non-wood benefits of forests may be valued highly, but this value can not be easily translated to income in the marketplace without mobilizing the public and political support. The main non-wood benefits of forests can be achieved through the development of ecotourism and non-wood forestry products sectors.

- *Ecotourism* and recreation are important non-wood benefits of forests, with a great income generating potential. A preliminary survey has revealed a demand for the following ecotourism activities in Armenia: bird-watching, botanical and zoological tours, geo-environmental tourism, cave tours, mineralogical tours, historical and ethnographical tours and all kinds of adventure tourism - horseback-riding, hiking, mountaineering, mountain skiing, waterspouts (yachting, windsurfing), parachuting and bicycling. All of the mentioned tours can be organized as both scientific tours and general tours for mainstream tourists and naturalists.

The following list presents the some of the privileges of Armenian forests in terms of ecotourism development:
- Biodiversity of forests (more than 262 tree and bush species),
- Diversity of forest landscapes in northern (mesic), central and southern (dry) Armenia,
- Unique hydrography (rivers, lakes, waterfalls, etc.) of Armenian forests,
- Well-expressed seasonality in Armenian forests,
- Availability of berries, mushrooms and other NWFP's.

Ecotourism is considered the most profitable segment of tourism industry. A study by Costanza et al, 1997 indicates that 1 ha of forest cover has $66 annual value in terms of recreation services. Based on this estimate the current 232,000 ha forest cover of Armenia has a potential annual value of $15 mln. if the basic impediment to the ecotourism and recreational business segment development – insufficient infrastructures – is effectively solved.

- Non-wood forest products[11]
The available valuable resources of non-wood forest products have a great income generating potential, if managed sufficiently. Collaborative efforts with the related industries will enhance the demand for NWFP: the related industries in this context are those that can use the NWFP as inputs for industrial processes, e.g. food industry, pharmaceuticals. The mature demand for NWFP's will increase the interest of new stakeholders in forestry conservation issues and can be a source of investments in sustainable management.

- Forest services
We are insufficiently familiar with the services forests provide. Prominent among these are climate regulation, flood control, soil conservation, water cycling, nutrient storage and recycling,—all of which are a basic part of any economy's support systems.

Principal services provided by forests

Service	Annual value per hectare (USD)
Climate regulation	141
Erosion control	96
Nutrient storage and recycling	361
Recreation	66
Other	305
Total	969

Source: Landmark article in *Nature* in May 1997, by Robert Costanza and 12 collaborators[12]

Recommended responsible agents	Recommended actions
MoA, MTED, Armenian Tourism Development Agency, Environmental NGOs, Research Institutes	• Conduct a valuation of non-wood forestry benefits of the forests • improve infrastructure conditions, • enhance cooperation of related industries • consider tax incentives for businesses to NWFP promotion
MoA	Analyze the availability of NWFP types and possible uses for related industries
Private investors, MTED, MoA, Hayantar ATDA, tourism associations	Develop ecotourism infrastructure and packages

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[11] For more details on non-wood forest products refer to appendix 5

[12] It was estimated that the earth's ecosystems provide $33 trillion worth of services per year—only slightly less than the $43 trillion worth of goods and services provided by the global economy. Of this total, Costanza and his coauthors estimated that the earth's forestland provides $4.7 trillion worth of services, or $969 of services per hectare per year.

Demand side measures

1. *Promote substitute product markets*

The consumption of products of laminate or other substitute materials is naturally increasing due to the low prices. These products are generally imported from other countries. The further promotion recommendation is to initiate substitute production capacities locally. Tax and other incentives for promotion need to be considered.

Recommended responsible agents	Recommended actions
Private investors, environmental NGOs	Analyze the applicability of substitute mass production establishment locally

2. *Develop green consumerism*

The public awareness should be promoted through green marketing tools, films, brochures, other initiatives. Tools which capitalize on value addition from environmentally favourable and legal products can be used to promote the image of legal processors.

Recommended responsible agents	Recommended actions
MNP, environmental NGOs	Develop a marketing plan for promoting the green consumerism, develop educational activities

Administrative measures

The need for regulations to protect forests is fundamental, as the market forces alone do not provide sufficient valuation for the social impacts and benefits of forest resources. The administrative measures aimed at conserving forests and detecting the forgery will *gradually* increase the transparency of the sector, promote the consolidation of industry entities and the demand of sustainable forest products, while shifting the demand entirely on the imports. The proposed responsible agents for all the recommendations stated below are primarily the MoA and MNP.

1. *Enhance the capacities and the knowledge base of the Forest Monitoring Centre (FMC).*

The centre, comprised of international and local experts, is supposed to monitor forest management and conservation actions by collecting data from ground based sources, as well as satellite images/aero-photos. A large involvement of all interested stakeholders and total transparency will enhance the public awareness.

2. *Introduce forest certification and chain of custody tracking procedures*

According to the Forest Stewardship Council (Mexico) guidelines, the tracking of both locally harvested and imported logs and processed wood products should be regulated by the Forest Code. An elaborate system of passes, licenses, hammer marks and permits requiring

multiple inspections and the decisions of higher officers need to take place before a logging permit can be issued. Passes authorizing transportation of the material need to be required at each stage of transaction. The log-tracking system starts with the forester who marks trees for felling. Each marked tree is assigned an inventory number which is painted on the tree itself. After felling, the same number is put on the logs cut from the tree and a sub-number is added for each individual log. The logs are also branded with hammer marks to identify the location from which they were harvested. When the logs are loaded onto a transport vehicle, a transit pass is issued to the operator for the specific load of logs and for a specified period of time. Every forest and police officer needs to have the power to stop a vehicle and check the contents using the transit pass and the accompanying list of logs as a reference. In addition, a network of check posts of the forest department as well as other agencies of the government should be put in place where the vehicle must stop and submit the documents for checking. When the log is scaled to determine its volume and quality (whether in the forest, at a log yard, or at a processing facility), the scaling information is added to the record, as this is the basis on which payment is made to the original owner (whether Hayantar or private businesses, whether to export or pass to other processing entities).

All of this information will allow tracing back to the individual forest management unit. The log-tracking system has loopholes as well. It is possible to cut off the ends of the logs, and put new identifying marks, and add hammer brands. Because the identifying marks on the logs must be keyed to other documentation, however, it is harder for this forgery to stay undetected. The further administrative impediments and penalties would be useful as well (confiscation of the transport vehicles and illegal logs, and imprisonment of the offenders, instead of fines).

3. Tighten the policy and regulation enforcement

The Forest Code and other general laws are not backed by sufficient mechanisms and by-law acts to make the enforcement of laws realistic and applicable. The policy and legislation procedures need to undergo sufficient discussion process with intensive public participation. Also policy and legislation process should be scientifically based and approved.

4. Integrate forest sector development projects and initiatives involving all the stakeholders of the sector

The abundance of international projects in this sector and fragmented nature of investments in the field makes the availability of an efficient information flow a necessity, in order to avoid the duplication of efforts. The systematic information exchange and discussions will foster the involvement of virtually all stakeholders in the development process, which will inevitable synergise the efforts.

5. Control financial flows of the wood processing industry

A closer control of the registered wood processing companies will gradually increase the transparency of the sector. Actions can be taken to make it more difficult to launder the profits from illegal logging. More than 100 countries now have anti-laundering laws. Technologies for identifying and tracking suspicious movements of money have improved. Listing of illegal logging as one of the predicates for money laundering in the relative legislation can become an effective administrative measure.

6. Consider the creation of a consultancy body within the organizational structure of Hayantar to include the opinions of key stakeholders in the decision-making process.

The stakeholders include primarily the policy makers, environmentalists and business leaders of the related industries. The consideration of diverse opinions will improve the sustainability and cross-monitoring system of management practices in the forestry sector.

The involvement of private sector companies in the forest sector management will gradually accelerate the process of innovative solutions to convert the forestry benefits to commercial values. Ultimately the disadvantage of forest scarcity in Armenia is a pressure to **innovate** and find solutions for conserving the forests. The creation of a consulting body is foreseen in the "Law on State Non-Profit Organizations" of 2001.

APPENDICES

Appendix 1

The scope and methods

Illegal logging or illegal forest activity is alleged to occur in many different ways. For the purposes of this study, we have chosen to profile the most significant uses of timber or wood: most importantly the use of wood as fuel, as raw material for the wood processing industry to produce end-products, such as parquet, doors, furniture, etc., and as a revenue source from exporting the unprocessed wood.

For each of these purposes a specific method has been adopted to assess the real volumes exploited versus the official numbers registered by Armstat and the data obtained from the Landsat analysis.

Numerous interviews were conducted in order to understand the real patterns of the forest sector. The representatives of regional Aarhus centers, local forest representatives and businessmen have been interviewed with specifically designed questionnaires.

While hard data on trade of forest products from illegal operations is virtually impossible to consistently gather, the sources like the UN Comtrade database provide an opportunity for cross-checking the exports data from one country versus the registered imports data from the peer country. The data obtained are still undervalued but provide figures closer to the reality.

Conversion factors

For the timber sector products, if volume data is not provided by the source, then weight (or surface area) is converted to wood volume using a world average of 1,4 m³ *per* tonne.

The following set of factors that indicates the volume of standing tree crop (wood raw material equivalent - wrme) needed to produce one unit of a final product were used throughout the industry analysis. These conversion factors are estimates and aggregates approved by the Forestry Commission of Food and Agriculture Organization of the United Nations.

Wood product conversion factors to wrme (standing volume)

Product	Measurement Unit	Factor to WRME
Fuelwood and charcoal	m³	1.25
Other industrial roundwood	m³	1.25
Softwood sawnwood	m³	2.13
Hardwood sawnwood	m³	2.09
Newsprint	tonnes	4.30
Printing and writing paper	tonnes	4.30
Other paper and paperboard	tonnes	4.30
Plywood	m³	3.67
Fibreboard	m³	2.35
Particleboard	m³	1.61
Veneer sheets	m³	3.67

Methodology of satellite image data interpretations

We used Landsat Thematic Mapper (TM) images for 1987-1989 and Enhanced Thematic Mapper (ETM+) for 2000-2001.

The border of the country was buffered to 10 km, and this extent was used to clip the satellite images in preparation for the analysis. The Landsat ETM+ images from 2000-2001 were analyzed first. After considering several options, we decided to use a Gaussian maximum likelihood classifier (Jensen, 2005). Each of the four 2000-2001 Landsat ETM+ and the four 1987-1989 Landsat TM scenes that cover the country were classified separately.

We created signatures for three classes: forest, non-forest, and water, using the ERDAS Imagine Seed Tool and the Signature Editor. Then the Separability and Contingency tools in ERDAS Imagine's Signature Editor were used to evaluate and revise the signatures by eliminating those that caused confusion between the forests and other classes. Once good Separability of the training signatures had been achieved, the Maximum Likelihood algorithm was used to classify each scene in ERDAS Imagine. This process was applied to each of the four 2000-2001 Landsat ETM+ scenes, and later repeated for each of the four 1987-1989 Landsat TM images.

Visual accuracy estimates of the 2000-2001 supervised classification were promising, but a few problem areas remained. There appeared to be confusion between forests and high meadows in June (the wettest month) images that created small areas of isolated forests classification in certain areas. These areas were submitted to local forest experts in Armenia for verification, along with field analysis and map verifications. Using existing maps, documentation, field visits, and personal field knowledge, they confirmed that these were false classifications of wet high meadows as forests. The Armenian foresters indicated that almost all of the problematic areas were in elevations above tree line (2,200-2,300 m above sea level). Using a Digital Elevation Model (DEM) with a 90-meter resolution, a mask was created to remove areas above 2,400 m (we made a 100 m of elevation allowance on the identified tree line to account for possible errors in the DEM). For the 2000-2001 images, 12,108 ha of misclassified forests in high altitude areas were eliminated from the classification using this mask. The 1987-1989 images were classified after applying the elevation mask.
We were initially concerned about confusing the orchards of apricot trees with forests. However, in the final classifications this vegetation was clearly discriminated from forests.

Accuracy Assessment

We used the Accuracy Assessment module in ERDAS Imagine to generate accuracy assessment statistics for 1987-1989 and 2000-2001 classified images. The software module generates random points within areas of the classified image. The reference values are assigned to the random points. The software then compares the reference values to the classified values to create accuracy statistics.

Following the recommendations of Congalton and Green (1999), we used 50 random points per class for the accuracy assessments. Since the images were classified into three classes (forest, non-forest, and water), 150 random points were generated for each of the images using stratified random sampling. Reference values for the random sample points were assigned using two independent sources of information: a) Topographic maps that delineate forests; and b) Armenian forest experts' confirmation of 50 points using field visits and recent local forest studies maps. The topographic maps were originally created in the 1950s and later revised and updated between 1971 and 1982 by the Institute of Geodesy and Cartography of the USSR using 1:14,000 aerial photographs. Once reference values were

assigned to the random points, the Accuracy   Assessment module of ERDAS Imagine was used to generate accuracy statistics for each classified image. The lowest overall accuracy for a single image was 87,84% (for P168R033_1987) and the highest was 96,43% (for P169R032_1989).

To obtain the total forest cover extent for the country, the final individual image classifications containing three classes (forest, non-forest, and water) for each time period were reclassified to binary forest/non-forest thematic layers. The individual layers for each time period were merged using the Merge function in ArcGIS version 9,1 (ESRI Redlands, California). The resulting merged images for each time period were clipped to the Armenian border extent. Then the total forest area for each time period was calculated by converting the number of pixels in each final merged layer to hectares. For 1987-1989 294,134 hectares and for 2000-2001 246,099 hectares were classified as covered by forests.

Discussion

The 1986-1989 Soviet National Forest Inventory for Armenia reported a forest cover area of 334,100 ha (Khurshudyan, 1999; Moreno-Sanchez and Sayadyan, 2005). There is a significant difference (39,966 ha) between our estimate for 1988 and this report. During the Soviet period, the Armenian national forest cover area was obtained by aggregating individual forest cover reports prepared by each of the forest management districts (also known as "forest enterprises") under the Soviet "Armforests" (or "Hayantar" in Armenian) agency (Kazaryan et al. 1974). These districts experienced illegal pressure to report optimistic numbers. Each forest district had 1:25,000 maps for the area under its jurisdiction. These maps were not integrated into a national level map for the 1986-1989 national forest inventories. Kazaryan et al. (1974) report the following forest cover estimates: 241,800 ha in 1956; 250,200 ha in 1961; 252,900 ha in 1966; and 260,700 ha in 1971. Comparing these authors' 1971 forest cover estimation to the 1986-1989 Soviet National Forest Inventory estimation reveals that between 1971 and 1988 there was an increase of 73,400 ha in the forest cover or an annual increase of approximately 4,320 ha per year. Although there were significant forest plantation programs carried out between the 1950s and the 1980s (Abrahamyan, 1960; Hakhinyan, 1973; Kazaryan et al., 1974; Grigoryan, 1979; Khurshudyan et al., 1987; Moreno-Sanchez and Sayadyan, 2005), it is doubtful that these plantations can account for the increase previously mentioned.

Forest cover estimates during the Soviet period, and particularly the Soviet forests inventory for 1986-1989 have come into question in recent discussions to create the Armenian National Forest Program of 2004, and during the World Bank's Natural Resources Management and Poverty Reduction project (2002-2008) (National Forest Program, 2004; Sayadyan personal communication). These accuracy concerns can explain in part the difference between our results and the Soviet estimates for 1986-1989.

In contrast, our 1988 estimate (294,135 ha) is close to the forest area reported in the 1:100,000 topographic maps created by the Institute of Geodesy and Cartography of the USSR (284, 950 ha). These maps were created in the 1950s but they were updated between 1971 and 1982 using 1:14,000 aerial photographs. The forest cover estimate from these maps was created in a homogenous way for the whole country, and it did not depend on individual forest cover reports from each of the Hayantar districts. Hence, it is considered today a more realistic estimate of the forest cover of the time than the official numbers reported in 1986-1989 Armenian National Forest Inventory (Sayadyan, personal communication).

Forest inventories

Forest inventories during the Soviet period were characterized by the use of "visual assessments". It has been proven that these practices grossly underestimated the mean

annual growth of Armenian forests (1,5m^3 per hectare versus 3m^3 per hectare by using sampling methods) (Thuresson et. al., 1999). This underestimation had a major impact on the determination of allowable cuts and management regimes. Periodical forest inventories were carried out in Armenia in 1956-58, 1966-68, 1976-78 and 1986-88. Most of the forest management practices carried out in Armenia during the Soviet period were protective in nature and ineffective. Over the years, these protective policies created mature and over-mature forests (with an average age of 100 years) with low densities, a very slow growth, and lowest natural regeneration (Thuresson et al., 1999). It has been estimated that the current forest cover is growing at only 30-40% of the potential growth that could be achieved on an average stand condition. For the period of 1950-1980, approximately 90,000 hectares of forest plantations were established to protect soil and water resources (Khurshudyan et al., 1987). This activity increased the forest cover in Armenia from 8% in the 1950s to 11, 2% at the beginning of the 1990s.

Before 1993, official and legal logging was limited to 60,000 -70,000 m^3 (Khurshudyan et al. 1987). The greater part of the wood harvested was used for heating purposes. The volume of industrial roundwood was only about 12,000m^3. The fuelwood harvest was usually limited to 60,000m^3 per year, of this about 8,000m^3 were considered selective cuttings, and 45,000m^3 as sanitary cuttings, and about 10,000m^3 were dry wood collected in the forest.

Starting from 1992-1993, when Armenia appeared in energetic and transportation blockade, the population impact on forests increased abruptly. Hayantar tried to organize a regular supply of fuelwood to the population in 1993. For this purpose, the level of official harvest was raised to 100,000 m^3, of which about 45,000 m^3 were allocated for fuelwood. In addition, the plan called for the collection of snow-break trees. Approximately 200,000 m^3 quotas were allocated among several forest enterprises in the next year. In reality, the plan was difficult to carry out because of fuel limitations, and transportation of wood to distribution areas was a major impediment (Ter-Ghazaryan, K.et al.1995). Thus, Hayantar was not able to control the situation and since then large-scale unregulated and uncontrolled logging of fuelwood and timber has started.

Appendix 2

Forest management bodies

The principal forest management body in Armenia is Hayantar CJSC, which till January, 2004 was within the Ministry of Nature Protection (MoNP). Then Hayantar moved to the Ministry of Agriculture and underwent structural/organizational changes. Similar changes took place in the MoNP. The current structure of forest management bodies in the country are summarized in Figures 5 and 6.

MoNP has two main bodies, the Bio-Resources Management Agency (BMA) and Inspection, mostly dealing with forest resources inventory, monitoring and inspectorate. The Forest Research and Experimental Centre (FREC) provide inventory data and management plans for Hayantar. FREC also provides training and field experiments to the Hayantar staff. The problem with FREC is the lack of forestry professionals, experience and corresponding facilities. An essential point with MoNP is that about 25% of the state forest estate is governed by National Parks, Reserves and Arboreta division of BMA, where the lack of professionals, facilities and financial means account for poor management practices.

The Inspectorate controls utilization of natural resources (including forest resources), legal utilization issues, also puts checkpoints to check the movement and sale of timber and NWFP. The problem here is the lack of human and financial resources.

The main governmental body currently dealing with Armenian forests is Hayantar, which administratively belong to MoA. Hayantar has a head office in Yerevan, with 5-6 divisions and 22 forest enterprises directly belonging to Hayantar. The important problem with Hayantar is the lack of professional foresters. Only 4-5% of all the employees have professional education or training in forestry. The majority of these 4-5% are rather aged foresters (above 70). The other serious drawback with Hayantar is the lack of corresponding material and technical basis, modern forest machinery, equipment and tools.

For the first time, a forest agency was established within the MoA in early 2004. It was supposed to provide policy, legislation, reforestation, inventory issues and development programs to Hayantar. All these issues are underdeveloped, which largely contributed to the spread of illegal activities and non-effective forest management practices in the country. But the Forest Agency had only a year's life and was soon transformed to the Forest Monitoring Centre (FMC) with about the same mandate. Thus, the FMC is a very young institution and in some departments, there are still many vacancies to be filled. The primary mission of such a monitoring centre was to conduct independent monitoring on illegal logging, which is hardly possible, as the FMC works within the MoA, which involves also Hayantar, the main forest manager.
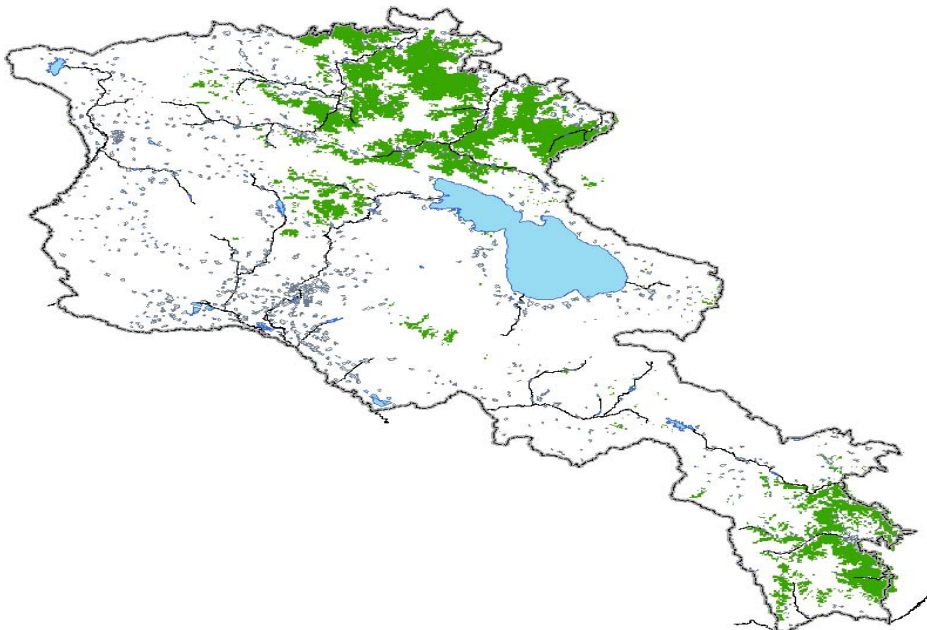
According to the RA Government decree N-1152 of 2005, the Ministry of Agriculture is assigned as the state authorized body of forestry monitoring and the Center for Forest Monitoring was established.
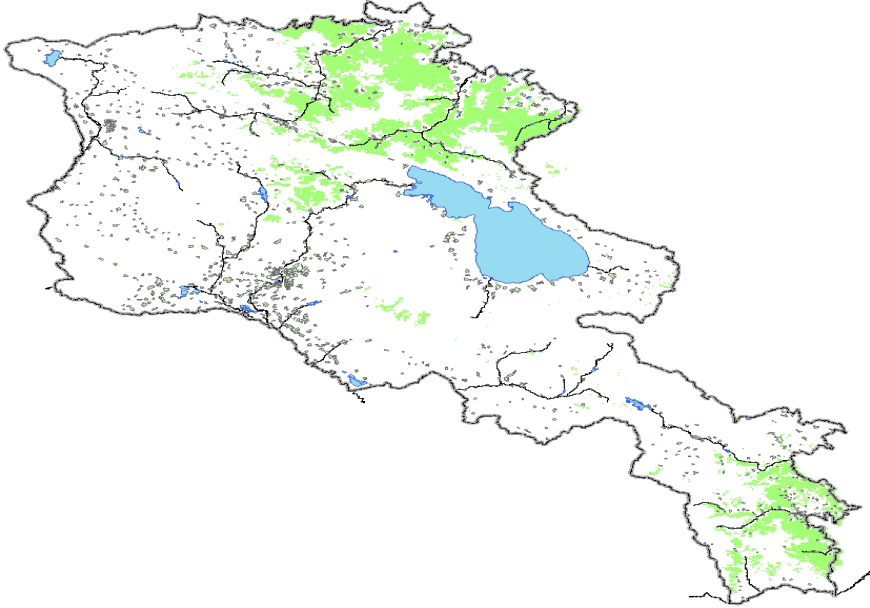
Appendix 3.

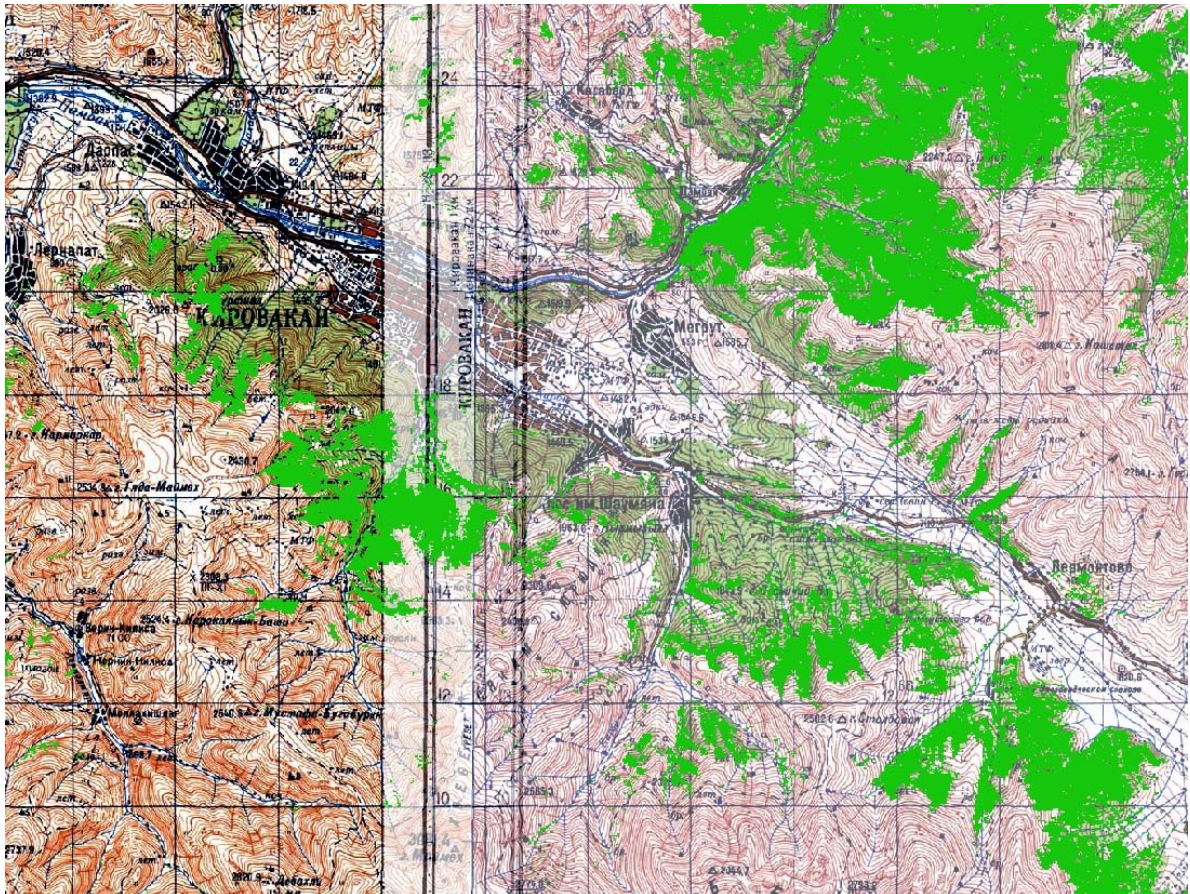Forest cover of RA in 1988 according to Landsat – 5, TM
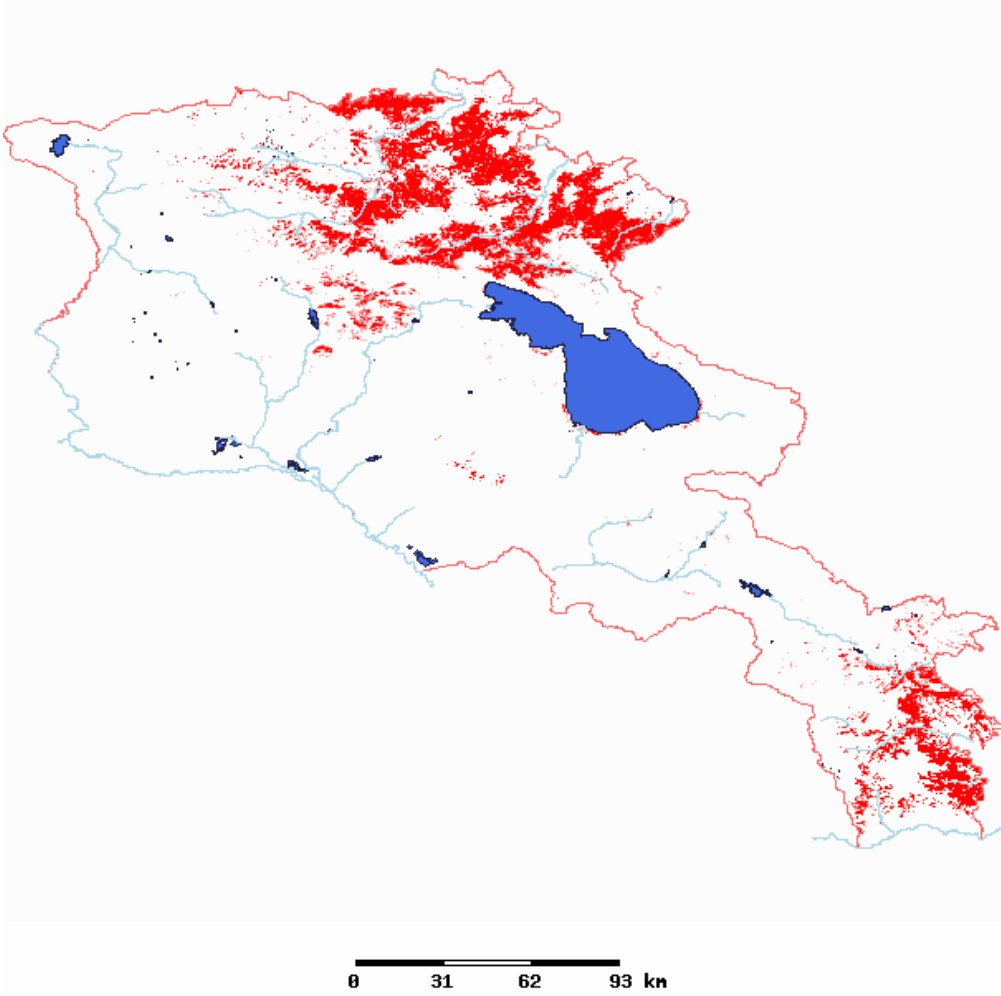
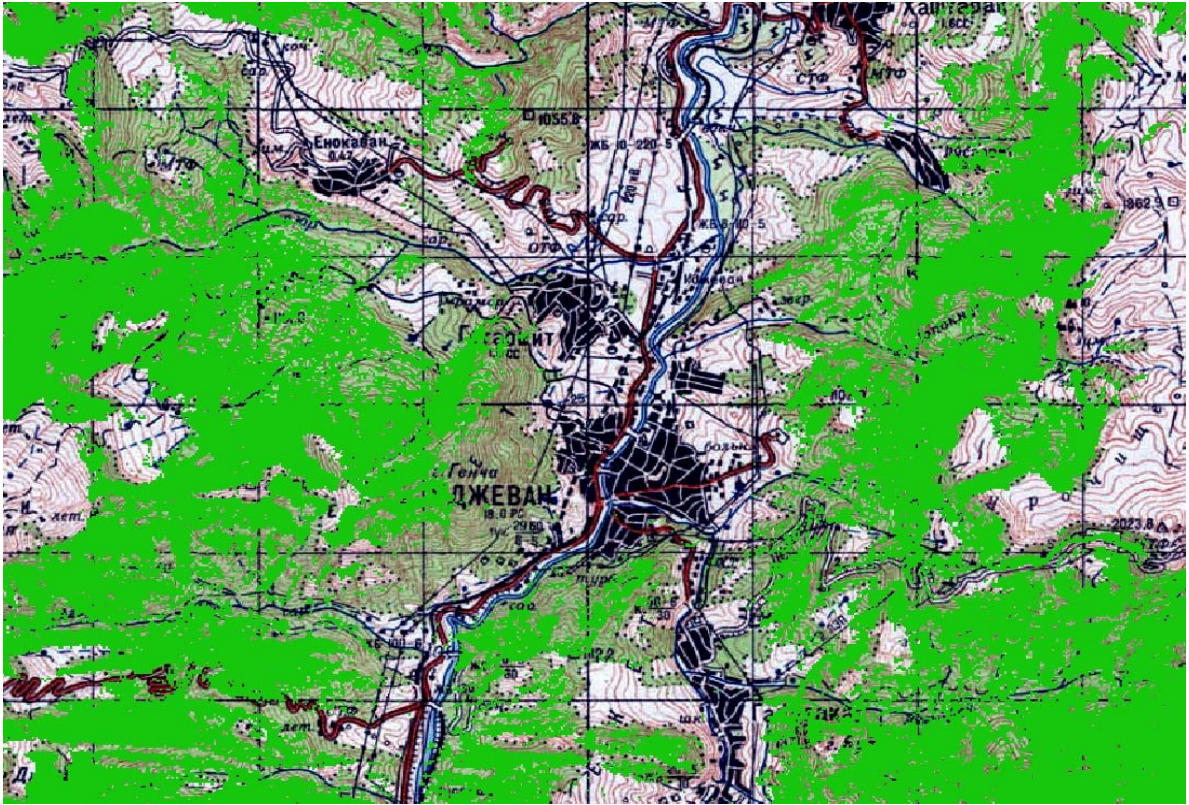Forest cover of RA in 2000 according to Landsat-7, ETM+

Forest cover of RA in 2006 according Landsat-5, TM

Evidence of deforestation in Vanadzor and Ijevan areas on the base of comparison of the Soviet era topographic map from 1986-1988 and Landsat-7, ETM+ from 2000

Appendix 4

The experience of other countries

<u>China</u>

The impressive information on China's experience helps us understand why our economy cannot take us where we want to go. Not only is China the world's most populous country but since 1980 it has been the world's fastest-growing economy.

As incomes have climbed in China, so has consumption. As China modernizes, its paper and wood consumption is rising. If annual paper use in China of 35 kilograms per person were to climb to the average level of developed countries level of 342 kilograms, China would need more paper than the world currently produces. There go the world's forests. China reasonably understands that there are simply not enough resources in the world. If the carbon emissions per person in China ever reach the U.S. level, this alone would roughly double global emissions, accelerating the rise in the atmospheric CO_2 level.

China faces a formidable challenge in fashioning a development strategy simply because of the density of its population; similarly, Armenia faces a tremendous challenge in fashioning a development strategy simply because of scarcity of its forests.

The pressures faced have the same underlying cause of scarcity. China has accepted the challenge by triggering innovation-based resource saving eco-economy, by promoting imports of timber (e.g. deliberately allowing the flow of illegal timber from Russia, by having 0 tariff rates on industrial roundwood imports and ban on exports, by promoting the value-added exports of wood products).

China also is engaging in a reforestation effort. In addition to planting trees in the recently deforested upper reaches of the Yangtze River basin to control flooding, China is planting a belt of trees across its northwest to protect the land from the expanding deserts.

China is heavily subsidizing tree-planting activities. This green wall (a modern version of the Great Wall) is some 4,480 kilometers (2,800 miles) long. This ambitious long-term plan is projected to take 70 years.

The state agents work with individual farmers in national agro-forestry programs to integrate trees wherever possible into agricultural operations. Well-placed trees provide shade, serve as windbreaks to check soil erosion, and reduce the need for fertilizers. The forest policy is the one that expands the earth's tree cover. A successful effort to reclaim the earth calls for a global reforestation.

<u>Japan</u>

In terms of land area, Japan is one of the densely forested countries in the world. However, due to a high population, forest area per capita is relatively low: 0,2ha/person- a fourth of the global average. 2/3 of the land is covered with forests, of which 41% consists of plantations.

Approximately 10 million ha of plantations have been established since the end of World War II for the rehabilitation of degraded land and the expansion of the timber industry. Felling is restricted in both plantation and natural forests wherever these fill a crucial role in protection of public benefits and services. Approximately 70% of plantations are less than 40 years old and therefore need sustained nurturing.

Realizing the crucial importance of forests, management systems have evolved that are consistent with the concept of sustained yield, striking a healthy balance between forest extraction and the capacity to regenerate both goods and services.

The history of organized initiatives to conserve forests dates back to the beginning of the Edo Era (the 1600s) with the designation of specific forest areas for water conservation and sand

stabilization. Official orders were issued placing restrictions on felling and exploitation in order to prevent forest degradation. The struggle to conserve forests was sustained through the centuries and eventually gave birth to the Forest Law enacted in 1897 establishing a nationwide forest protection system.

Seventeen public interest criteria serve as the basis for establishment of protection forests. Implementation of soil conservation work has been intensified, particularly in sites where some degraded land or mountain streams have the potential for causing disaster.

Sweden

Nowadays, the forest cover in Sweden constitutes around 25 mln. ha or about 65% of national territory, but still in the 1880s the forest cover was around 20-25% of national area. The reason for that was steel production on the base of charcoal, timber extraction for the paper/pulp industry, construction and large-scale livestock breeding. Vast forested areas, particularly in the southern and central parts of the country were destroyed and deforested, i.e. large land areas were switched from forest cover to other land-use, e.g. pasture-land, arable and other types of land-use. In 1903, the Swedish government accepted the first National Forest Policy, which stressed the needs of large afforestation and reforestation activities. During some 60-70 years, the forest-covered area became more than 50%. Nowadays, the annual increment in Swedish forests constitutes 100 mln. m^3 and the annual cutting level is 80 mln. m^3. Forests belong mainly to private forest owners, large timber companies and a small portion – to the state. About 15% of national export now comes from the forest sector. The last forest policies accepted in 1978, 1993 and recently accentuated the importance of sustainable forest management practices and balance between three pillars of the sustainable development concept: social, economic and environment. Swedish forestry traditions, history and culture are very valuable for other nations like Armenia, to learn and apply for local conditions.

France

France has the largest forest cover in western Europe - 15,3 mln. ha (if one will not take into account Sweden and Finland) or 28% of national area. Like Sweden, France also experienced a strong pressure on national forest resources in medieval ages and during the industrial revolution. At the same time, still in 18-19th century's French kings had several orders to save national forest resources, to plant forests and conduct large greening activities.

In the French Alps, where relief and topography is very complicated and natural climatic conditions are rather similar to Armenian conditions, the forest cover is still extending. In the turn of 20th century, the French Alps were largely deforested. Heavy rains, hails, snow and glaciers started to wash away fertile soil and cause uncontrollable erosion and land degradation. Starting in 1905-1910, the national policy was to stop all these negative environmental events and conduct large reforestation. First of all, technical installations were constructed to stop mud-flows and torrents. Then comparatively smooth surfaces and valleys were planted. As a result of the hard work, where all local communities were involved, during less than 100 years steep slopes were reforested and afforested. Nowadays, forest exploitation on these slopes is conducted in a sustainable way, i.e. timber extraction is organized in such a way and rate that the forests cover does not decrease.

All the above-described activities are well documented and archived. These materials are available and very useful to learn silviculture practices on such a complicated terrain. This experience could be very useful for Armenia and Armenian foresters.

Appendix 5.

Non-wood forest resources

Non-wood forest products include agricultural lands (arable land, pasture land, hay-making areas, vineyards, fruit orchards), wild fruits, edible and medicinal plants, etc.

Wild fruit trees and bushes occupy around 10,000 ha area and are distributed in north-eastern and south-eastern Armenia as well as in Vayots Dzor. Caucasian pear and eastern apple are main wild fruit trees in Armenia. The wild pear trees alone occupy 2,000 ha and produce more or less 700 tonne of harvest.

According to L. Makhatadze and I. Danielyan (Makhatadze, 1977), 1,478 tonne pear and 305 tonne apple were harvested in Northern Armenia (beside Tavush, Dilijan and Vanadzor areas). The same authors said that from northern Armenian forests it is possible to harvest 1,356 tonne of cornelian cherry. In other words, it is possible to get annually 350 tonne of fruits and berries, whereas the national candy industry needs several tens of tonnes of such crop to prepare high quality jams. The same source informed that only in the Ijevan region it is possible to harvest 60 tonnes of walnut.

According to the FAO report, the gross income from NWFP's represented some 20 percent of the total revenue of Hayantar in 1995/96. Even if this percentage is distorted owing to the artificially low stumpage revenues, it still indicates the importance of NWFPs. The main income was generated from hay-making, livestock farming, forest fruits, Christmas trees, honey, medicinal plants and hunting (Table 3).

NWFP's constitute an important source of income and employment. These activities are part of Hayantar's management and provide permanent employment to 26 percent of its staff. In some forest enterprises, NWFP's represent more than 50 percent of the total income. Each forest enterprise is allowed to organize its own sale of these products on terms set by the central administration concerning minimal prices and permitted quantities.

Experience in the NWFP sector suggests that the liberalization of pricing and decentralization of decision-making could also have a positive influence on the forestry sector. Three major reasons have been identified for the relative importance of NWFP's: the comparatively free pricing system, the possibility to retain income and the lower degree of central planning.

NWFP resources of Armenian forests

NWFP OF ARMENIAN FORESTS	
Number of tree and bush species	262
Wild fruit tree and bush species (10,000 ha)	130
Decorative tree and bush species	116
Tree and bush species for technical usage	120
Honey providing tree and bush species	115
Total flora	3,500 species, of which 262 arborescent
Total medicinal plants	2,000 species
Edible plants	500 species (in the beginning of 20th century) and 100 species nowadays
Most collected edible plants	40 species
Mushrooms	150 edible species, of which only three are widely collected

The following table (Table 4) shows a breakdown of the earnings from agricultural and non-wood forest products in 1996. It can be seen that together with meat and forest fruit production, Christmas tree selling and hay collection account for two-thirds of the sub sector's income.

NWFP of Armenian forests

HAYANTAR'S MAIN AGRICULTURAL AND NON-WOOD FOREST PRODUCTS IN 1996			
PRODUCT	QUANTITY	INCOME ('000 DRAMS)	PERCENTAGE OF INCOME
Grain *(tonnes)*	681	13,951	3.5
Hay *(tonnes)*	3,170	19,883	19.1
Forest fruits and berries *(tonnes)*	490	10,739	10.4
Honey *(kg)*	2,015	6,280	6.1
Meat *(kg)*	31,800	18,883	18.2
Milk *(kg)*	146,800	11,158	10.8
Eggs	2,000	90	0.1
Christmas trees	20,000	20,000	19.2
Wool *(kg)*	2,200	65	0.1
Vegetables *(kg)*	28,000	2,545	2.5
Total		**103,594**	**100.0**
Note: 500 drams = US$1. (*Source:* Hayantar.)			

The following wild fruit and nut species are of substantial interest both for market production and for conservation of the genetic resources: apple (*Malus orientalis*); pear (*Pyrus caucasica*); mountain ash (*Sorbus aucuparia*); hawthorn (*Crataegus caucasica*); plum (*Prunus divaricata*); apricot (*Armeniaca vulgaris*); almond (*Amygdalus fenzliana*); cherry (*Cerasus avium*); hazel (*Corylus avellana*); walnut (*Juglans regia*); cornelian cherry (*Cornus mas*); sea buckthorn (*Hippophae rhamnoides*); rose (*Rosa*); and medlar (*Mespilus germanica*).

The following are the priority issues for the development of the NWFP sector: medicinal plant resources are not sufficiently well known; the potential of fruit- and nut-trees is at present underutilized; and scarce budget resources do not permit an appropriate research program on genetic resources of wild fruits, berries and nuts.

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