

Forest policies, management and conservation in Soviet (1920–1991) and post-Soviet (1991–2005) Armenia

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SUMMARY

The extent and condition of forest ecosystems in Armenia have decreased drastically since the disintegration of the Union of Soviet Socialist Republics (USSR). This decline is not only a consequence of the recent history of the area, but also the result of decades of forest policies, management and forest-use practices. To reverse the negative trends, it is important for stakeholders, scientists, resource managers and policy makers (in Armenia and abroad) to understand the influential factors in the decline, yet such information is scarce, highly fragmented, written in Armenian or Russian, and inaccessible to the international community. This paper aims to contribute to the knowledge base of the international community by presenting and contrasting the most important issues and processes that have affected forest cover in Armenia during the USSR (1920–1991) and independence periods (1991–to date). For each period, the legal framework, the forest inventory practices, forest use, management and conservation practices, the forestry education, and the perception of the forests by forest communities and society at large are presented and discussed. Except for the social perception of the forests, the most relevant aspects of these issues have scarcely changed from one period to the next. There is a need to address the most pressing problems and improve the current conditions of the forests and the forestry sector in Armenia.

Keywords: Armenian forests, Caucasian region, deforestation, forest conservation, forest management

INTRODUCTION

The forests of the Caucasian region, which encompasses Georgia, Armenia, Azerbaijan, south-eastern Russia, north-eastern Turkey and north-western Iran, are a hotspot for biodiversity and contain a large number of endemic plant and animal species (Conservation International 2005).

In this dry-subtropical region, forests also play a major role in preserving favourable environmental conditions for sustainable development, particularly in small countries like Armenia. Throughout history, the goods and services provided by the Armenian forests have played an important role in satisfying the needs of the local human population. The great social, political and economic changes that have occurred since the collapse of the United Soviet Socialist Republics (USSR) have created tremendous pressures on these forests, and current developments and policies continue to endanger their existence. However, the current extent and condition of the Armenian forests is the result not only of the events of the last 15 years, but of decades of management policies and practices.

As Armenia and the former Soviet republics in the Caucasian region make the transition to democracies and to a global market economy, and if the concept of sustainable development is to be implemented at different scales, it is important for stakeholders, scientists, resource managers and policy makers (in Armenia and abroad) to understand the factors and learn from the processes that have influenced changes and led to the current state of Armenian forests. This information is scarce, highly fragmented, written in Armenian or Russian, and not available in publications that are easily accessible to the international community. This paper aims to fill this gap by presenting and contrasting the most relevant events and factors that have affected the forests in Armenia during two clearly distinct periods, namely the Soviet period (1920–1991) and the post-Soviet era (1991–2005). To provide better historical context, a brief overview of the pre-Soviet period is also presented.

We aim to review the forest policies, laws and regulations, forest inventory practices, forest use, management and conservation practices, characteristics of forestry education, and perception of the forests by the forest areas inhabitants and society at large. These are fundamental to understanding the reasons for change and the current state of forest ecosystems in Armenia. To do this effectively, we begin with overviews of Armenian human and physical geography, the main characteristics of the Armenian forests and the pre-Soviet period. We then go on to describe features of the Soviet and independence periods. Finally, we compare and contrast the Soviet and independence periods, and suggest how some of the most pressing problems might be addressed.

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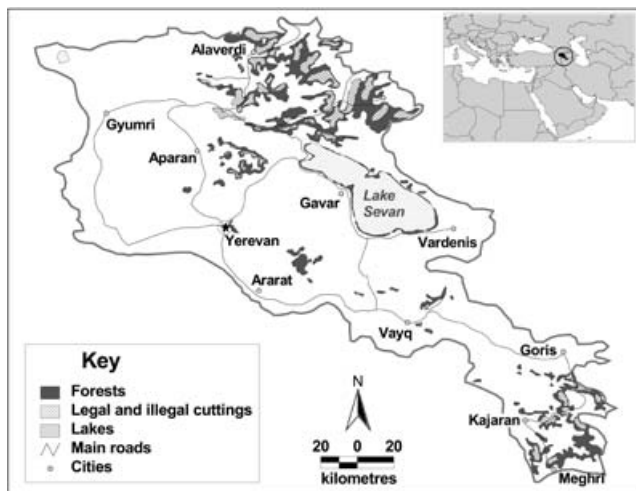


Figure 1 Location of Armenia, and estimated extent of the forest cover for the year 2000.

OVERVIEW OF ARMENIAN HUMAN AND PHYSICAL GEOGRAPHY

Located in south-west Asia (Fig. 1), over the centuries the Republic of Armenia enjoyed brief periods of autonomy and came under the sway of various empires, including the Assyrian, Roman, Byzantine, Arab, Persian and Ottoman empires. Armenia was incorporated into Russia in 1828 and into the United Soviet Socialist Republics (USSR) in 1920. Independence was achieved after the disintegration of the USSR in 1991. The early years as an independent nation were marked by war and economic hardships. From 1988–1994, Armenia was involved in an armed conflict with Azerbaijan over Nagorno-Karabakh, a primarily Armenian-populated region, assigned to Soviet Azerbaijan in the 1920s by the USSR government. In May 1994, there was a cease-fire, but by then the economies and environment in both countries had been severely damaged (CIA [Central Intelligence Agency] 2004).

The constituent 11 provinces have a human population of 3 326 448 (estimate for 2003 based on the first Armenian census of 2001), which is decreasing at an annual rate of 0.07%, mostly because of emigration. Approximately one-third of the total population is concentrated in the capital Yerevan (1 091 230 people) and in the Ararat plain region. Over 98% of the population aged 15 and over can read and write (CIA 2004).

The country has a total area of 29 800 km² (comparable to the size of Belgium). Altitude ranges between 400 m above sea level along the Debed River (Northern Armenia), to 4090 m above sea level in the Aragats Mountains (Central Armenia). Armenia is situated in a dry subtropical climatic zone. Precipitation ranges from 250–300 mm per year on the Ararat plain to 1000 mm per year in the Aragats Mountains. Several distinct microclimates are created by

the complicated topography. The terrain complexity and microclimatic diversity, as well as the fact that Armenia is located at the crossroads of four different floristic provinces (Old-Mediterranean, Near-east Asian, Iran-Turanian and Caucasian), produce different vegetation types with high biodiversity and high percentages of plant and animal endemism. Today the country is included in the Caucasus and Irano-Anatolian biodiversity hotspots (Conservation International 2005). Biomes range from a semi-desert in the Ararat plain to sub-alpine and alpine on the summits of the Aragats Mountains. There are *c.* 3600 species of high-vascular plants in the country (Grigoryan 1979; Armenian Ministry of Nature Protection 1999; Vardanyan 2003). The dendroflora is composed of 110 tree and 152 bush species (Abrahamyan 1960; Grigoryan 1979; Armenian Ministry of Nature Protection 1999; Vardanyan 2003).

The country faces several environmental problems and challenges (CIA 2004) including: (1) soil erosion (it is estimated that two-thirds of the country suffers from heavy to medium erosion processes; Hayrapetyan 1976, 1979, 2000; Hayrapetyan *et al.* 1990), (2) soil and water pollution from toxic chemicals, (3) irrigation and drinking water shortages, (4) pollution and draining of Lake Sevan, the main source of drinking and irrigation water in Armenia, (5) significant deforestation rates and (6) biodiversity loss.

OVERVIEW OF THE ARMENIAN FORESTS

Armenian forest vegetation can be grouped into five major types, namely (1) oak forests composed of several species of *Quercus* (mainly *Q. macranthera*, *Q. iberica* and *Q. araxina*), (2) beech forests dominated by *Fagus orientalis*, (3) hornbeam forests dominated by *Carpinus betulus* and *C. orientalis*, (4) dry shrub vegetation composed of several species of bushes and (5) grasslands or wooded grasslands dominated by different types of grasses combined with sparse bushes (Sayadyan 2005a). The first three vegetation types occasionally form pure high forests of the species, but more commonly they form high forests composed of complex mixes of oaks, beech and hornbeam (Sayadyan 2005a). According to Khurshudyan (1999a), in 1988, forest vegetation (including all five types previously listed) covered an area of approximately 460 000 ha.

Out of this 460 000 ha of forest vegetation, 334 100 ha were covered by wooded vegetation (vegetation types 1–4). In 2000, 245 000 ha (or approximately 8.2% of Armenian territory) were covered by natural or planted high forests, 77 050 ha by coppice forests and the remaining 23 450 ha by dry shrub vegetation (Moreno-Sanchez & Sayadyan 2005; Sayadyan 2005a).

We use the terms ‘forest cover’ or ‘forest’ to denote high forests (natural or created through plantations) dominated by tree species (Table 1). The Armenian forests are the ecosystems under the highest socioeconomic pressures, threat of degradation or destruction, and with the greatest relevance to environmental conservation in the country (Thuresson

Table 1 The area and percentage of total forest cover by dominant tree species in 1941 (Maghakyan 1941), 1956 (Abrahamyan 1960), 1966 (Hakhinyan, 1973), 1997 (Makhatadze 1977) and 1988 (Khurshadyan 1999a).

Dominant tree species	1941		1956		1966		1977		1988	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Mix of oaks (<i>Quercus</i> spp.)	80 241	28.21	83 294	34.5	87 200	34.47	97 852	35.8	120 000	35.9
Beech (<i>Fagus orientalis</i>)	109 201	38.40	85 310	35.7	89 700	35.45	89 533	32.8	96 600	28.9
Hornbeam (<i>Carpinus</i> spp.)	60 365	21.23	46 543	19.2	46 600	18.42	50 976	18.6	55 100	16.5
Pine trees (<i>Pinus</i> spp.) Mostly from plantations	927	0.33	969	0.4	2500	0.98	1295	0.5	17 700	5.3
Juniper (<i>Juniperus</i> spp.)	7862	2.77	6357	2.4	4200	1.66	12 714	4.7	8400	2.5
Mix of other broadleaf deciduous trees (mainly hornbeam coppice <i>Carpinus</i> spp., lime <i>Tilia cordata</i> , ash <i>Fraxinus</i> spp. and maple <i>Acer</i> spp.)	25 783	9.07	10 180	7.8	22 800	9.02	20 741	7.6	36 300	10.9
Total	284 379		241 753		253 000		273 111		334 100	

et al. 1999; Thuresson 2003; Sayadyan 2005b). Most of the Armenian forests are found in mountainous terrain between 500 and 2400 m altitude. The north-eastern and south-eastern parts of the country and the eastern bank of Lake Sevan have the most favourable climatic and environmental conditions for forest growth. The forest cover is highly fragmented (Fig. 1), 62% being in the north-east, 36% in the south-east and only 2% in the central region of the country (Fig. 1).

The most recent data on dominant tree species in natural forests, plantations and the areas they cover, and the percentages of the forest cover that they represent, are more than fifteen years old (Table 1).

The transformations and current state of the Armenian forests result from decades of management policies and forest-use practices by several stakeholders and economic activities. The activities that have had greatest impact on the Armenian forests are agriculture, horticulture and animal husbandry (mostly by communities and individuals), and forestry activity itself (by the Soviet, and later, Armenian governments, and since independence by illegal forestry operations). Planned industrial production or uses of the forests was very limited during the Soviet and independence periods for reasons that we will elaborate on later.

We highlight forestry-sector activities and, when relevant, other activities which have influenced the extent and condition of the forests.

THE PRE-SOVIET PERIOD

Political instability marked the social and economic scenes in Armenia from the 1st to the 18th centuries AD, the area being invaded by Rome, Persia, Arabs, Mongols and the Turk-Seljuk. These wars devastated the economy, as well as the environment. There are few records from this period describing the forest cover. Armenian kings were fond of hunting and established several forest plantations (Khorenatsi 1981), however there are no traces of these plantations because they were located in easily accessible areas in the middle of

the Ararat plain and long ago converted to agricultural use. Arab historians (Istakhri and Ibn Al Fakikh) from the 8th and 9th centuries noted that Arab invaders cut and exported high quality timber from Armenia. This was the case during the Byzantine, Turkish and Persian invasions (Leo 1917). In mediaeval ages, large areas of forest in Armenia were transformed into agricultural land at lower altitudes and into grasslands for cattle and sheep grazing at higher altitudes (Sayadyan 1997).

Historical assessment of the extent of forest cover (Moreno-Sanchez & Sayadyan 2005) and other studies (Kuznetsov 1900, 1909, 1915; Kara-Murza 1929, 1931; Shelkovnikov 1929; Zedelmeyer 1930; Maghakyan 1941; Yaroshenko 1941, 1956) indicate that by the 17–18th centuries, forest cover was *c.* 18% of the total area of the country. From the 18th to the 20th centuries, human impact on the forests changed in nature from mainly deforestation for agriculture and horticulture (lower altitudes) and animal husbandry (higher altitudes) to overexploitation for industrial uses, such as copper mining and processing. Cuttings for these industrial uses were more intense, and there are around 20 small metallurgical factories located across the country. Eight of these factories were located in the north, around the cities of Alaverdi, Akhtala and Shamlugh, and 12 of the factories were in the south, near the cities of Kapan, Kajaran, Agarak and Meghri (Melkonyan 1955) (Fig. 1).

Before 1828, forests in Armenia were in the hands of small private owners. In 1828, when Armenia joined the Russian Empire, the majority of the forest areas were included under the Tsar's Forest Department Authority and the remaining areas were transferred to churches, private landowners and communities (Khurshadyan *et al.* 1987).

ARMENIAN FORESTRY SECTOR DURING THE SOVIET PERIOD (1920–1991)

The early decades of the Soviet period were characterized by economic and social hardships, economic growth being

given priority. Starting in the 1950s, as economic conditions improved and the effects of decades of overuse and mismanagement became evident, conservation policies and management practices were put in place. We present information about the specific events and processes that took place during this period and led to the current state of the Armenian forests.

Legal framework

The laws, codes, and forest policies during the Soviet period had the following major characteristics. All forests, minerals and water were declared property of the state; the resources were to be managed by the state or in very few cases by communal farms or cooperative unions. All Armenian forests were to be managed for conservation and protection objectives; forest laws and regulations were not strictly enforced and they did not fully achieve their stated goals on the ground. We will elaborate briefly on each of these characteristics and make reference to the specific laws and policies that created them.

The USSR constitution of 1918 (and its revisions in 1936 and 1964) declared that all forests, minerals and waters were state property. In 1920, all Armenian lands and forests were declared state property. Only small forest patches around towns and communities were designated as *sovkhos* (local community state farms) and *kolkhoz* (local community cooperative unions) for their management and use.

The core of Soviet Armenia's forest policy and management practices from the late 1970s to Armenian independence in 1991 was derived from the 1978 USSR Forestry Code that emerged from the USSR Constitution of 1977. The Ministry of Forest Economy of the USSR was responsible for the management, use and conservation of all forest resources. According to the 1978 USSR Forestry Code, all forests in the USSR were divided into three major groups, namely protected forests (Group I), forest with restricted industrial uses (Group II) and industrial forests (Group III). In 1978, all Armenian forests were designated as Group I forests, being managed as state reserves and sanctuaries, forests in riparian areas, forests for recreation and aesthetic value (mostly around towns, communities and resorts), forests bordering steppe zones, natural forests or plantations for soil conservation and conservation of biodiversity. In these forests only sanitary felling (cutting dead, infested or diseased trees) and 'reproductive' cuttings (in mature forests to promote regeneration) were allowed. In the 1980s, 14.7% of all forests in the USSR fell under this category (Nilsson *et al.* 1992).

Forest inventory practices

Forest inventories during the Soviet period had two prominent characteristics; they were based on 'visual assessments', and were centrally prepared and processed (usually in Moscow or at a regional forestry office, such as in Georgia). The first led to gross underestimations of key forest variables, and the second did not allow Armenia to create

specific inventory and monitoring techniques appropriate to the type of forests and management objectives of the Armenian forests, or to develop local expertise and infrastructure to monitor its forest resources.

The 'visual assessment' approach used in all the Soviet forest inventories consisted of experienced foresters walking through the forest stands and visually estimating key forest parameters such as age, height, diameter and species composition. There was no robust sampling design based on inventory sites or statistical methods to extrapolate the sampled tree characteristics to homogenous forests stands. Using aerial photography and/or field visits, these visual assessments first classified the forest cover into homogeneous forest stands, and then estimated, based only on field experience, the stand characteristics and timber volumes. Obviously, this approach was highly subjective and key forest stand variables were only guessed. For example, the mean annual growth of the Armenian forests was grossly underestimated (at 1.5–2.0 m³ ha⁻¹ yr⁻¹ according the last Soviet inventory [Khurshudyan *et al.* 1987; Sayadyan & Nalbandyan 2002] versus a figure of 3.0–4.0 m³ ha⁻¹ yr⁻¹ estimated using sampling methods in 1998 [Thuresson *et al.* 1999]).

The first forest inventories in Armenia were carried out in the mid-1920s. Early in the history of the Soviet forest inventories, in 1938, the need to estimate both timber and non-timber goods and services provided by the forests was recognized (Khurshudyan *et al.* 1987). However, the estimation of the non-timber goods and services (such as protection of other resources) was even more subjective than that of timber resources, and this was never used to assign an economic value to these goods and services. An efficient mechanism (for example subsidies or different kinds of incentives) to translate the value of non-marketable goods and services into economic benefits for the inhabitants of the Armenian forests and/or the republic's economy was never developed.

National forest inventories were carried out in Armenia in 1956–1958, 1966–1968, 1976–1978 and 1986–1988 (Table 1). According to the last Soviet national forest inventory (1986–1988), there was 41.74 million m³ timber stock (Khurshudyan *et al.* 1987; Sayadyan & Nalbandyan 2002). All the Soviet inventories followed the 1951 Forest Inventory Guidelines published by the Ministry of Forest Economy and were conducted by the Georgian Forestry Institute (under the Department of Forests of the Republic of Georgia). The information generated was used as a basis to design management prescriptions and regimes which shaped the current condition of the Armenian forests.

Forest use, management and conservation

During the Soviet period there were important social and economic changes that affected the use, management and conservation of the forests in the country. We can broadly identify two stages that had different characteristics in this regard, namely the 1920s–1940s and 1950s–1991s.

The 1920s–1940s were characterized by economic and social hardships. Large amounts of fossil fuels, mineral resources, water, timber and wildlife were extracted and used to create the new Soviet economy, and later rebuild the country after World War II and help it to compete with the West during the Cold War years. Forests were overexploited to satisfy immediate economic needs. During these decades the country switched from an extensive agrarian economy to an economy that emphasized industrial activities (mining, industrialized agriculture, roads and railroads building) with great impact on its natural resources and environment (Khurshudyan *et al.* 1987). The creation of large collective agricultural units (sovkhoz and kolkhoz units) starting in the 1930s (and continuing through the 1950s) dramatically increased the impact on soil and water resources (Khurshudyan *et al.* 1987). Inadequate agricultural practices in these units caused erosion and degradation of large areas (Hayrapetyan 1976, 1979, 2000; Hayrapetyan *et al.* 1990).

During the early decades of the Soviet period, forest management practices were influenced by the official view that the forests of the USSR constituted a vast inexhaustible resource that needed to be fully used to create a strong country. This led to a lack of interest in developing intensive silvicultural practices, such as species composition management or intermediate cuttings (such as thinning), which are of particular relevance to the type of forests and conditions existing in Armenia. Later, the protectionist forest policies in Armenia that dominated the second period also prevented the development and implementation of these silvicultural practices. In this context, large regulated and unregulated forest cuts occurred most intensively around industrial centres all over Armenia. For example, large quantities of timber were extracted from the forests starting in the areas next to industrial cities such as Kapan, Kajaran, Agarak and Alaverdy (Fig. 1) to satisfy the need of the copper-molybdenum mining industry for timber for mine shafts and railways. Commonly these cuts targeted the best tree specimens of high-value timber (mainly oak, beech and walnut) for their dimensions and durability. These practices resulted in the creation of forest stands devoid of high-quality germplasm and dominated by low-value tree species (Khurshudyan 1999a).

By the 1950s, the negative effects of activities from previous decades became evident, earlier in Armenia than in the rest of the USSR. This was in grand part due to the harsher environmental conditions that existed in the country, the low forest cover and their more immediate and evident association with the protection of other resources such as water and soil. Strong protectionist policies were adopted to manage the Armenian forests. These policies aimed to keep Armenian forests mostly untouched without regard for the needs of the population, and without considering that a certain level of economic use of the forest (for example production of high-value timber from precious species) could be achieved without compromising their extent or capacity to protect other resources. Hence, most of the value of the

Table 2 Percentage of trees of the main broad-leaf species by age category. Source: Khurshudyan (1999a).

Age class (years)	Tree species		
	Oak (%)	Beech (%)	Hornbeam (%)
Young stands (1–40)	4.4	0.8	0.9
Middle age stands (40–100)	55.3	47.3	34.7
Mature stands (100–140)	12.9	23.6	19.6
Over mature stands (More than 140)	27.4	28.3	44.8
Total	100.0	100.0	100.0

Armenian forests rested on non-marketable goods and services such as protection of other resources, aesthetic value and recreation, and also on the support of small-scale subsistence activities such as unregulated grazing and extraction of timber products of small dimension for construction, agriculture and horticulture. The economic benefits of these goods, services and activities are hard to quantify in monetary terms and are rarely included in regional or national cost and benefit. These policies had important consequences. Firstly, the forest areas inhabitants and adjacent communities perceived that the forests had little or no monetary value for enhancing their economic situation if they were to be used according to the law. Secondly, there was no opportunity to develop experience in managing the types of forest existing in Armenia with multiple objectives such as protection of soils, recreation, grazing and high-value timber production (Khurshudyan *et al.* 1987).

There is one more important consequence of the protectionist forest management policies that dominated the Soviet period. This management approach in conjunction with the visual assessments' underestimation of the mean annual growth of the forests led to the creation of overstocked and over-mature forests with low density, low annual growth rates and very poor regeneration (Ter-Ghazaryan *et al.* 1995; Khurshudyan 1999a; Thuresson *et al.* 1999; Thuresson 2003). Approximately 30–40% of the trees of the main broad-leaf species in the Armenia fall in the over-mature category (Table 2), and fewer than 5% fall in the young age category (Khurshudyan 1999a). Also, the current forest cover is growing on average at only 30–40% of the potential growth that could be achieved (Khurshudyan *et al.* 1987). We can infer that, if properly managed, the Armenian forests could support some level of sustained economic use of stock without compromising their protection objectives.

Old-growth forests may help to achieve some of the management objectives of Group I forests, such as protection of biodiversity, however all of the forests in the country today have these characteristics, which make them more susceptible to pests and diseases, and reduce their capacity to recuperate from disturbances (Ter-Ghazaryan *et al.* 1995; Khurshudyan 1999a, b). This is of great relevance because of the stresses and pressures to which the Armenian forests are subject today. Some old-growth forest must be maintained and the best place to do so would be in the network of national parks and reserves.

The rest of the forests could be subject to interventions to move their age structures toward younger, faster-growing compositions capable of supporting the extraction of wood products (such as firewood and timber from high-value species) and hence provide continuous economic benefit to the forest communities.

From the 1950s to the 1980s, about 90 000 ha of forest plantations were established, mainly around Lake Sevan and the large population centres (Khurshudyan *et al.* 1987). These plantations were established in response to the lowering to the Lake's level (18 m between the 1930s and the 1980s) and to protect the Lake's shores from regressive erosion caused by the rivers and creeks that flow into the Lake. In these reforestation and afforestation projects, native species such as ash (*Fraxinus excelsior* and *F. oxycarpa*), maple (*Acer campestre*, *A. hyrcanum*, *A. ibericum*, *A. laetum*, *A. platanoides* and *A. trautvetteri.*), linden (*Tilia begonifolia* and *T. cordata*), walnut (*Juglans regia*), pine (*Pinus hamata*), see-buckthorn (*Hippophae rhamnoides*) and poplar (*Populus alba*, *P. euphratica*, *P. tremula* and *P. nivea*) were used. These plantations increased the forest cover in Armenia from *c.* 8% in the 1950s (Abrahamyan 1960) to *c.* 11.2% at the end of the 1980s (Sayadyan & Nalbandyan 2002). However, these efforts were mostly promoted and implemented by the Soviet central and Armenian governments with little participation from the local communities (Ter-Ghazaryan *et al.* 1995; Thuresson *et al.* 1999; Sayadyan 2005*b*). This lack of community motivation and involvement led to the mismanagement and degradation of large portions of these plantations as soon as government intervention ceased. For example, 30 000 ha of the forest plantations established during the 1950s in areas under sovkhoz and kolkhoz control were mismanaged and neglected up to the 1990s because of the higher priority given to horticulture and animal husbandry (sheep and cattle) by the people living in these communities (Khurshudyan *et al.* 1987).

In 1958, the first national forest reserves were established in Khosrov (29 200 ha), Dilijan (29 000 ha) and Shikahogh (10 000 ha). In these reserves only very limited scientific investigation was allowed. Other activities such as grazing and tourism were not allowed. Since independence, urban sprawl, tourism, illegal hunting and unregulated grazing have greatly impacted these reserves (Sayadyan 1999). During the Soviet years, a network of 22 State Forest Reserves was developed to include many valuable forest patches in different parts of the Republic. Those reserves were designed to protect valuable or rare trees species such as nut (*Corulus colorata*), teak (*Taxus baccata*), juniper (*Juniperus polycarpus*, *J. sabina*, *J. foetidissima*) and pine (*Pinus silvatica*). Today the network of protected areas in Armenia covers 141 600 ha (approximately 5% of the national territory), divided into two national parks, three state sanctuaries and 23 state reserves (American University of Armenia 1998). It is worth noting that these reserves and sanctuaries are composed of forested areas with no representation of other types of precious or endangered ecosystems.

To this day, Armenia has not had a large forest industry. The main forest industries consist of small particle-board factories, furniture factories and wood handicrafts. The particle-board and furniture industries are mainly concentrated in the capital Yerevan and Ijevan in north-eastern Armenia (Fig. 1). From the 1960s to the 1980s, an estimated 60 000–70 000 m³ of timber were extracted per year from the Armenian forests, mainly as result of the removal of dead and infected trees (Khurshudyan *et al.* 1987). This volume of timber did not satisfy the industrial and construction demand for forest products. Starting in the 1960s, timber imports from Russia grew exponentially and, by the 1980s (and until the independence), reached approximately 90% of the demand for forest products in Armenia (Thuresson 2003). Even the demand for oak to prepare barrels for ageing the traditional Armenian brandy was satisfied by imports from the northern Caucasian region.

During the Soviet years, in parallel with industrialization and intensive agricultural development, the population and number of settlements increased significantly. At the beginning of Soviet period, the total population in Armenia was 720 000 people (Avagyan 1975; Valesyan 1981). By the 1960s, it was close to two million due to immigration and the high population growth rate after World War II (Avagyan 1975; Valesyan 1981). The new settlements and their associated road networks had an impact on the forest cover, particularly at lower altitudes where agricultural and horticultural activities encroached on the native forests. Extensive animal husbandry for sheep, goats and cattle at higher altitudes impacted the areas next to sub-alpine and alpine meadow pastures.

Forestry education

The way Soviet forestry professionals and technicians were educated influenced the manner in which the Armenian forests were studied and managed. The forestry education opportunities were centralized in institutions in Russia, Ukraine and Georgia. Most of the education concentrated on principles and management practices developed for the temperate coniferous industrial forests of Siberia and Eastern USSR. Little or no regard was given to mixed broadleaf deciduous forests managed for conservation purposes of the type in Armenia. Forest inventories and best management practices relevant to the type of forest existing in Armenia were rarely taught or researched, disassociating theory from practice and contributing to the mismanagement of the Armenian forests (Thuresson *et al.* 1999).

The centralization of education also meant that Armenia did not develop its own forestry education infrastructure (human, material and knowledge) to address the specific type of forests, environmental conditions or management objectives, or the cultural characteristics of the population. This became a major problem at the time of independence.

Social perception of the forests

Communities in forest areas have always benefited from the use of the forests to support subsistence, and city and rural people have greatly enjoyed the recreation opportunities offered by the forests, such as hiking and camping, hot water springs, hunting and skiing. However, during the Soviet period, several of the factors previously described dampened active involvement of Armenian society at large, and the forest communities in particular, in the protection and management of the forests. Almost all the demand for forest products was satisfied by imports from other Soviet republics, and all the planning, management, protection and forestry education activities were centralized. In addition, the central and Armenian Soviet governments played a dominant role as the owners and caretakers of the forests. Further, the laws did not allow the country as a whole, and the communities in the forest areas in particular, to use the forests to some degree to generate economic benefits (Ter-Ghazaryan *et al.* 1995; Thuresson *et al.* 1999; Sayadyan 2005*b, c*).

Even though the different forest area stakeholders recognized the role and importance of the forests, this understanding did not result in their widespread involvement or interest in conservation or creation of new forest policies to better protect and manage the forests. It was not until 1985 that the first non-governmental organization (NGO) ‘Goyapahpanutyun’ (later renamed Green Union of Armenia) was created.

ARMENIAN FORESTRY SECTOR DURING THE INDEPENDENCE PERIOD (1991–2005)

The independence years in Armenia have seen political violence and several economic shocks. The collapse of the USSR in 1991, compounded by a devastating earthquake in 1988, and the 1988–1994 war with neighbouring Republic of Azerbaijan, created a transportation, economic and energy blockade. These events imposed tremendous pressures on the forests as sources of energy and potential although illegal income. Only in the last five years did the economic situation improve slightly, political and social institutions become stronger and the population begin to adjust to the new market economy.

Legal framework

The current laws, codes and forest policies have been almost identical to their Soviet-period counterparts. They declare that all forests are property of the state, the forests are to be managed by the state (very few by communal state farms) and all forests are to be managed for conservation and protection of other resources. The enforcement and implementation of laws and policies are at best very lax. The revision and modernization of forest laws and policies is given low priority in Armenian legislature.

The first post-independence Armenian Forestry Code was published in 1994. This code was closely based on the 1978 Soviet Forestry Code. All forests were again declared property of the State and commercial or industrial uses of the forests were not allowed. All the forests were reserved to protect the environment and other resources, and only sanitary and regeneration cuttings were allowed. They were divided into three protection classes, namely (1) forest for soil and water protection, (2) forests for social uses (around cities, towns and recreation areas) and (3) protected forests in forest reserves and sanctuaries (Armenian Forestry Code 1994, Chapter III, Article 9). The Code has not achieved its stated goals; the very general guidelines have not been followed by more specific legal documents or handbooks for implementation in the field. Even the government agencies in charge of implementing the code have a very loose interpretation of it. For example, in 1999, the Yerevan Brandy Company signed an agreement with the Armenian government through its representative the state forest agency Armforest to obtain 2000 m³ of high quality oak timber to renew its old barrels for ageing brandy (Thuresson 2003). However, according to the Armenian Forestry Code the necessary cuttings to supply the volume and quality of timber requested are illegal.

In 1995, Armforest was created to be in charge of all forest management and protection functions. In the same year there was an attempt to revise and create a new national forest policy (Armenian Ministry of Nature Protection 1996). At the time of writing, the preliminary proposal that resulted from this effort had been trapped for more than eight years in the Armenian legislature, and has not yet been revised or approved due to the very low priority given to the forestry sector by the Armenian legislators. This preliminary proposal stated that the objectives of the new Armenian forest policy should be to (1) create conditions which lead to the proper economic use of the forest (control illegal cuttings, allow income generating activities such as the production of high quality timber, and facilitate reinvestment of profits in forests and forest communities), (2) be consistent with other national policies, especially those concerned with the environment, agriculture, forest industries and rural development, (3) analyse and learn from the best forest policies in developed countries, (4) strengthen the human and institutional capacity for forest policy formulation, monitoring and execution and (5) improve forest regeneration, reforestation, afforestation and community forestry. The ongoing (2002–2006) World Bank project ‘Armenian natural resources management and poverty alleviation’ (SIDA [Swedish Agency for International Development] 2002; World Bank 2002) may serve to move forward the process of revising and approving a new forest policy in the country.

Forest inventory practices

Since independence, lack of financial resources, infrastructure and well-educated and trained personnel has not allowed the implementation of a forest inventory with national coverage.

Most of the forest management and conservation decisions across the country have been based on the 1986–1988 Soviet National Forest Inventory (Thuresson *et al.* 1999; Thuresson 2003). The last time aerial photos images were used to estimate the extent of the forest cover in Armenia was in the 1970s, and state-of-the-art forest inventory and monitoring methods and technologies have not been used in the country.

In 1993, the cooperation in forest inventories with the Georgian Forestry Institute came to an end, further activities by this institute being payable for as consulting services, which have been beyond the financial capabilities of the country. Some forest inventories have been carried out (see below) but they have had limited geographical coverage. Most of these inventories have relied on the old Soviet methods of visual assessments with limited direct measures, sampling or application of statistical methods. The only advance has been in the use of information technologies for data capture, manipulation and the creation of maps using geographic information systems.

In 1998, the Forest Research Experimental Center (FREC) was created with the purpose of working on forest resource inventory methods and technologies, mapping, establishment of the forests cadastre and forest ecosystem monitoring. During 1998, this Center carried out a project in conjunction with the Swedish National Board of Forestry (NBF; Thuresson *et al.* 1999). The project concentrated only on selected representative forest areas across the country. The study statistically analysed the existing forest inventory data, created a sampling design, carried out field measurements and applied statistical methods to extrapolate the sampling results for key forest variables such as age, annual growth and standing timber volumes (Thuresson *et al.* 1999; Sayadyan 2000). The methods used provided data with small systematic errors. The FREC used a two-stage sampling procedure. In stage one, stratified probability proportional to size (PPS) sampling (Cochran 1977) was carried out to select sub-compartments for the establishment of circular sampling plots. The purpose of the stratification was to divide the forests into groups of homogeneous sub-compartments, and hence reduce the variation (of mainly volume and growth) within each stratum. This in turn yielded low variance in the data. In stage two, a systematic sampling of the circular sampling plots was carried out within each sampled sub-compartment. The results of this study strongly contradicted some of the key forest variables generated by the 1986–1988 Soviet National Forest Inventory, such as the estimates of mean annual growth of Armenian forests ($3\text{--}4\text{ m}^3\text{ ha}^{-1}\text{ yr}^{-1}$ versus $1.5\text{--}2.0\text{ m}^3\text{ ha}^{-1}\text{ yr}^{-1}$). This means that these forests have the capacity to grow faster than previously estimated and hence, if well managed, potentially support some level of regulated commercial use such as the production of high-value timber (oak, beech, walnut and mulberry, among others) used in high-quality furniture, traditional musical instruments and brandy barrels.

The results of other forest inventories carried out since independence have been totally disregarded by the end-user Armforest. They consider that these inventories have not

been conducted in an efficient manner and that they have not used reliable methods, and are also resentful that Armforest foresters have not been invited to provide input in the process. In 1999, the FREC commenced inventory activities in the Nojemberjan region (northern Armenia), to provide Armforest with information for management by updating maps and forest inventory records. The field sampling and data collection were carried out without any planning or robust sampling design. The results of the FREC study have not been accepted by the Armforest regional offices in the area, and the data and management recommendations have been all but ignored. The fact that FREC is under the Ministry of Nature Protection and Armforest under the Ministry of Agriculture has contributed to poor communication, coordination and trust between the two organizations.

Forests use, management and conservation

The independence period can be roughly divided into two stages with regard to the events that affected forest use, management and conservation in the country from 1991–1997 and 1998–2005. The first stage is characterized by extreme disruption of the political and economic infrastructures, war and abrupt interruption of the oil gas and forest product imports from former USSR republics. During the second stage oil and gas supplies stabilized close to normal levels, the economic situation improved and the nature of the impacts on the forests changed. We describe the events and processes that took place during these two stages.

At the time of independence (and until 1994), Armenia was at war with Azerbaijan. Right after independence, all oil and gas, and forest product imports from Russia and other former USSR republics ceased abruptly (Ter-Gazaryan *et al.* 1995; Armenian Ministry of Nature Protection 1996; Thuresson *et al.* 1999; Armenia Country Profile 2002). These imports used to satisfy most of the energy needs in the country and more than 90% of the demand for forest products in Armenia. The resulting energy crisis forced many small cities and local forest communities during most of the 1990s to obtain up to 50% of their household energy needs from unregulated fuelwood cuttings (Thuresson *et al.* 1999). Even in Yerevan, an estimated 60 000–80 000 trees were cut during the 1990s for fuelwood (American University of Armenia 1998; Thuresson 2003). Up to 70% of the deforestation that occurred during the early 1990s was caused by cutting for firewood, the remaining 30% attributed to illegal exports (Armenian Online Weekly 2004; Armenia Tree Project 2005).

The conditions that existed during early independence fostered the creation and growth of a massive black-market economy in all sectors, but particularly in the forestry sector. To this day, almost 100% of forest product production is part of an extensive black-market economy (Armenian Ministry of Nature Protection 2000). During the 1990s, authorized forest cuttings were $70\,000\text{ m}^3\text{ yr}^{-1}$, of which $20\,000\text{ m}^3\text{ yr}^{-1}$ were considered commercial cuttings (a clear contradiction of the 1994 Armenian Forestry Code; Armenia Country

Profile 2002). However, at least 1 000 000 m³ yr⁻¹ timber were cut illegally (Armenia Country Profile 2002). The 1998 Armenian Forest Resources Assessment Project showed that legal and illegal cuttings during the 1991–1996 period amounted to 600 000 m³ yr⁻¹ (Thuresson *et al.* 1999), considerably higher than recent estimates of the mean annual growth of 450 000 m³ yr⁻¹ (Thuresson *et al.* 1999; Thuresson 2003).

The nature of the illegal cuttings started to change in 1996–1997, when the flow of oil and gas imports returned to almost normal levels. High-grade cuttings for illegal exports to Iran, Turkey and Europe involving the best specimens of high-value timber species replaced cuttings for firewood as the main source of impact to the forests (American University of Armenia 1998; Thuresson 2003; Sayadyan 2005*b*). These cuttings are done hastily and without proper methods to protect the remaining forest stands. The extraction methods used are not suited for the steep conditions prevailing in most of the forests, poorly planned roads have accelerated both erosion and sedimentation of hydrological networks, and caused landslides in several areas (Sayadyan 1997; Sayadyan & Hakobjanyan 2002; Sayadyan & Nalbandyan 2002; Tarverdyan *et al.* 2003). These cuttings are leaving behind forests dominated by low-value species devoid of high-quality sources of germplasm to regenerate the forests (Thuresson *et al.* 1999). Initially this activity was scattered, poorly organized and mostly confined to remote areas. However, as profits from these activities have accumulated, the bands of illegal loggers have become better organized, have obtained more equipment, corrupted forestry and local authorities, expanded the geographical extent of their activities and become more daring in their operations. Illegal cuttings currently take place closer to population centres, main roads and within protected areas and parks where the perpetrators leave a belt of untouched forests in areas that are visually exposed to population centres and roads and ransack the rest of the forest (Sayadyan 2005*b*).

Planned forest management activities have been extremely limited. Forest management plans are centrally created at the Armforest office in Yerevan. These plans have a 10-year horizon, which is broken down into annual tasks. The current management policy is very conservative, emphasizing the protective and ecological role of the Armenian forests, and there is no planned economic use of the forests. Most management plans still use as a basis the results of the last Soviet national forest inventory (1986–1988), the proposed cuttings are not carefully scheduled and coordinated, and for the most part they are never fully implemented on the ground (Thuresson *et al.* 1999; Sayadyan 2005*b*). Corruption by politicians and forestry and local authorities has prevented the implementation of forestry laws, and has made it almost impossible to implement any management plans (Armenian Ministry of Nature Protection 1996; Thuresson 2003) in both the areas managed by Armforest and the network of national parks and reserves (Sayadyan 1999, 2000; Thuresson *et al.* 1999; Thuresson 2003).

Despite the high biodiversity value of the Armenian forests and the stated goal of conservation of the forests (1994 Armenian Forestry Code), there are currently no plans for protection and management of biodiversity. Neither are there plans for pest and disease management in the natural forests or the existing forest plantations. Currently leaf-eating pests such as *Haltica quercetorum*, *H. armeniaca*, *Euproctis chrysorrhoea*, *Operaphthera brumata*, *Erannis defoliaria*, *Curculio glandium*, *Carpocapsa splendana*, *Ocnea dispa* and *Malakosoma neustria* are a serious problem in oak stands in central and south-eastern Armenia. Armforest and the Armenian government do not have the resources to be able to deal with these threats.

The forest plantations that were established from the 1950s to the 1980s to protect Lake Sevan have been gradually destroyed (Sayadyan 1997; CIA 2004). From 1992 to 1995, 4500 ha of these plantations were clear-cut along the shores of the Lake by local communities in their pursuit of fuelwood (Sayadyan 1997). These clear-cuts have contributed to further lowering of the water level in the lake, sedimentation and decline of the water quality (Sayadyan 1997). Another important ecological degradation process in the country is the unregulated cut of bushes and chaparral-type vegetation, especially in the southern part of Armenia where very dry conditions exist. These cuttings (mainly to satisfy fuelwood needs) have created severe erosion and are contributing to mud flows during the intense summer rains (Sayadyan 1999).

Forestry education

After independence, Armenia was left without institutions to teach forestry principles and techniques, and efforts have been made to build a forestry education infrastructure. In the mid-1990s, the Armenian Agricultural Academy (AAA) introduced two forestry specializations (engineering and park management). These programmes were started with a severe shortage of experienced professors in forestry and related sciences. Since 1994, different international projects and consultants' reports have emphasized the need for the creation and modernization of secondary and higher education forestry institutions in the country (Tarverdyan *et al.* 2003). Nevertheless, it was not until 2003 that the AAA created a new Forestry Department, and 40 students will graduate within the next five years. This will practically triple the current number of forestry professionals in the country. The AAA is paying particular attention to creating an education programme that balances ecological, social and economic principles, and that is grounded in a sustainable approach to natural resources management. Also, in contrast with the Soviet period, the programme will teach knowledge and techniques that are appropriate to the types of forests and social, economic, and environmental conditions existing in Armenia (Tarverdyan *et al.* 2003).

Social perception of the forests

After independence, the population in general, and the forest communities in particular, were forced to turn to the forests

to satisfy immediate needs, relegating to second priority their importance for conservation and protection of other resources. Most of the factors that discouraged society in general, and the forest communities in particular, from taking an active role in the protection and management of the forests during the Soviet period continued after independence. These factors are: the role of the Armenian government as owner and caretaker of the forests; the laws against the use of the forests to some degree to generate monetary benefits (for example through the production of high-value timber) without compromising their role in conservation.; the centralized administration of the forests; (now in Yerevan); and the lack of consideration for local and societal input in forest planning, management or protection. New factors have appeared: corruption of forestry and local authorities; illegal logging; and lack of attention to the forestry sector by legislators and the Armenian government (Sayadyan 2005*b, c*).

In this context, poor rural communities have no option but to turn to illegal cutting and a forest-products black-market economy to satisfy their needs and generate monetary income. These communities still give higher priority to agriculture and animal husbandry, from which they can obtain food or more immediate economic benefits (Sayadyan 2005*c*).

Armenian society as a whole is aware of the importance of the forests to protect soils and hydrological systems and the relevance of this role for the future of the country (Sayadyan & Nalbandyan 2002). However, this awareness has not led yet to a widespread increase in the political pressure to analyse and do something to address the root causes of the deforestation and degradation of the Armenian forests. Creation of NGOs such as Armenian Forests (<http://www.armenianforests.am/home.html>) is playing an active role in promoting awareness and creating political pressure for change.

CONCLUSIONS

Like the other 14 republics that composed the USSR, Armenia had strongly formulated forest policies, management practices and social-cultural traditions that had positive and negative aspects. Despite the Republic's declarations of independence in 1991, these traditions, policies and practices are still strongly present, and there remains inertia in the way many activities are carried out in Armenia after more than 10 years of independence. This legacy is still one of the largest impediments to the development of new policies and management practices that can lead to sustainable forests in the context of the new social, political and economic conditions that exist in the country.

The most relevant factors of the forestry sector have remained largely unchanged from the Soviet to the independent period. Forest resources have continued to be largely owned and managed by the state with no consideration for local input or needs. Current forestry legislation and policies are for all practical purposes identical to their Soviet counterparts, and they have proven equally inefficient in

achieving their stated goal of protecting the forests. Well-organized forest management and protection activities based on up-to-date reliable information are non-existent.

There is an immediate need to implement sustainable management approaches that are congruent with the new economic, social and environmental circumstances of the country. These approaches have to integrate multiple objectives and use the forests in a manner and rate which will make this resource available to future generations and will promote continuous economic benefit, social acceptability and sound environmental conditions for human development. As long as the forest communities (and the country as a whole) are not capable of generating income from the forests to better their conditions, they will continue to have low or no interest in their conservation.

The forest areas in the country are in very poor condition and very fragmented. There is hope and a time-limited opportunity to save the Armenian forest from disappearing within the next few decades, a possible outcome that would have repercussions for the sustainable development not only of Armenia, but the whole Caucasian region. The most recent and reliable estimations of the potential growth of the Armenian forests suggest that with careful management a certain level of economic use can be achieved without conflicting with conservation and protection objectives. A new generation of forestry professionals is being prepared with the tools and knowledge that will enable them to contribute to moving toward sustainable forests.

We believe that Armenia needs to take a number of immediate steps. The extent, stock, growth and conditions of the forest need to be accurately quantified. A national forests information system needs to be created, and this information disseminated to scientists and the general public. Forest management plans with multiple-use objectives that are adequate for each type of forest and condition need to be drafted, involving local communities and the channelling of economic benefits of these activities directly to them. Economists, managers, politicians and society in general need to be educated about the importance of the forests as part of ecological, social and economic systems that are necessary for the subsistence of the country and the Caucasian region. Effective legislation and national forest policy congruent with the principle of sustainable development need to be created that can be effectively implemented on the ground. An economic value needs to be assigned to the non-marketable goods and services provided by the Armenian forests to be able to include them in development plans, design economic stimuli and compensations, and evaluate contributions of the forestry sector to the national economy. The existing network of national parks and reserves should be effectively protected and extended to include other types of precious or rare ecosystems besides forests. The property of the forests should be transferred to local communities or private owners to avoid current decline. There should be stiffer penalties for corrupt administrators and politicians. International agreements (such as the certification of forest products) are needed to eliminate

the vast profits of black-marketers who export high quality timber to Iran, Turkey and Europe.

Similar events and processes have affected neighbouring former Soviet republics within the Caucasian region. As Armenia and these countries embrace democracy and integrate into the global market economy, they will need to adjust their policies and forest management practices to their new social, political, economic and environmental conditions. Sharing information and experiences will help stakeholders, scientists, resource managers and policy makers (in Armenia and abroad) to understand the factors and learn from the processes that have influenced the evolution and led to the current state of the forests in Armenia. For example, the Armenian experience suggests that policies, laws and regulations aimed at protecting forests without allowing inhabitants to derive a sustained economic benefit from them are destined to fail. Several countries in the region and throughout the developing world are on the path of repeating this mistake.

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