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**Vulnerability and Adaptation of the Forest Sector of
Republic of Armenia to Climate Change**
(Report brief)

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This is a brief summary of the report prepared within the framework of “Enabling Activities for the Preparation of Armenia’s Second National Communication to the UNFCCC” UNDP/GEF/00035196 Project. The Project is a joint initiative of UNDP and Ministry of Nature Protection of Armenia and is funded by GEF. The purpose of this research is to assess the vulnerability of Armenia’s forest sector to the global climate change and assist to the preparation of the relevant chapter of Armenia’s Second National Communication to the UNFCCC.

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Overview

Since the First National Communication of Armenia (1998), a number of basic documents on forest have been developed: National Forest Policy and Strategy (2004), Forest Code (2005), National Forest Program (2005), Action Plan of Measures to Address the Problem of Illegal Logging (2005), Program of Implementation of State Forest Monitoring (2006), some executive legal acts (2005-2007), etc.

The main, fundamental principle of the Armenian national forest policy is that forests are the national inheritance and they should serve to future generations as well.

Armenia has extremely poor forest resources, and, according to the Armenian Forest Code, forest lands are the state's exclusive domain (ownership). For the purpose of enlarging the forest cover, the rights for community and private ownership have also been included in the Code. The Code both preserves the state ownership over forest lands and encourages establishment of new forests on community or private lands, with subsequent acquisition of the rights for ownership, after they have been transformed into forests. This provision will encourage development of various forms of ownership and will, at the same time, create pre-conditions for extending the forest cover.

Since the First National Communication of Armenia (1998) till 2004 the forest sector was regulated by the Ministry of Nature Protection of Armenia, so the governing and regulatory functions were combined. In 2004, by the decision of the Government of Armenia, the "Hayantar" SNCO that had the regulatory functions for the sector was removed from the structure of the Ministry of Nature Protection and included in the structure of the Ministry of Agriculture, which is now the authorized management body for forest maintenance, protection, reproduction, and use (see the Table 1). The "Hayantar" SNCO, together with its 22 regional forest enterprise branches (see the Table 2), performs the management of around 75% of forest zones and has under its governance 18 out of the 23 forest reserves of the republic. The Ministry of Nature Protection of Armenia is entitled with the state supervision function. Around 25% of forest zones fall under the category of specially protected areas ("Dilijan" and "Sevan" national parks, "Khosrov" and "Shikahogh" reserves and some reservations) and are governed through the Bio-Resources Management Agency of the Ministry of Nature Protection of Armenia and its subordinated SNCOs. The new Forest Code has extended the forestry management functions of regional and local self-government bodies and provided with improved mechanisms for trust management and establishment of community and private forests.

Table 1. Main forest management agencies in Armenia

#	Name of agency	Functions
1.	Crop Production, Forestry and Plant Protection Department of the Ministry of Agriculture of Armenia	Formation of state policy on preservation, reproduction and utilization of forests, development of relevant strategy and legislation
2.	“Hayantar” SNCO of the Ministry of Agriculture of Armenia, with its 22 forest enterprises	Implementation of state policy on preservation, reproduction and utilization of forests; preservation, protection, reproduction and efficient utilization of state forest lands in Armenia
3.	“Center for State Monitoring of Forestry” SNCO of the Ministry of Agriculture of Armenia	Implementation of state monitoring over forestry, including illegal logging issues
4.	State Environmental Inspectorate of the Ministry of Nature Protection of Armenia	Supervision over compliance with the rules and requirements defined by environmental legislation
5.	Bio-Resources Management Agency of the Ministry of Nature Protection of Armenia	Provision of services for the implementation of forest management policy, including state registration and stock-taking of forestry, forestry-planning works (organization of government contractual works)
6.	“Forest Research-Experimental Center” SNCO of the Ministry of Nature Protection of Armenia	Implementation of forest research and experimental works, including forest-construction and forestry management planning activities

Table 2. List of “Hayantar” SNCO’s forest enterprise branches

#	Names of forest enterprise branches	Total area (ha.)	Marz (region)
1.	Lalvar	26082	Lori
2.	Dsegh	13790	
3.	Jiliza	14887	
4.	Gugark	28155	
5.	Stepanavan	6965	
6.	Tashir	7143	
Total		97022	
7.	Ijevan	25512	Tavush
8.	Sevkar	20484	
9.	Noyemberyan	27263	
10.	Artsvaberd	42667	
Total		115926	
11.	Goris	13045	Syunik
12.	Kapan	42444	
13.	Meghri	26496	

14.	Sisian	4737	
	Total	86722	
15.	Hrazdan	20925	Kotayk
	Total	20925	
16.	Gyumri	6021	Shirak
	Total	6021	
17.	Yerevan	875.9	Yerevan
	Total	875.9	
18.	Yeghegis	11045	Vayotz Dzor
19.	Jermuk	4532	
	Total	15577	
20.	Tchambarak	10978	Gegharkunik
	Total	10978	
21.	Aparan	9064	Aragatsotn
22.	Byurakan	5404	
	Total	14468	

According to the Forest Code, forests in Armenia fall into the following categories, based on the main purpose of their use:

- a) protective;
- b) special-protective;
- c) production.

Note: Overall assessment of forest stock based on the new classification system has not been completed yet, therefore quantitative data are available for several forest enterprises only.

Stock-taking and planning works in the forest management sector have almost been suspended since 1993, and therefore the forest system generally has to rely on outdated information preserved since the forest stock-taking of 1993. These data do not reflect subsequent qualitative and quantitative changes of forest stock.

According to the results of the 1993 stock-taking, the area of Armenia's forest lands is 459.900 ha., including:

- a) 392.300 ha. of forest lands, which includes 334.100 ha. of forest cover areas;
- b) 67600 ha. of non-forest lands.

Note: These data do not include the quantitative changes of forest lands in the subsequent time-period.

The forest wood-stock in Armenia till the intensive forest-felling of 1992-1996 made up 41.74 mln m³. The average total annual increment made up 0.45 mln m³, average stock per ha. – 125 m³, average increment – 1.3 m³, average site index (*bonitet*) – III-6, average density – 0.55, average age – 99.

Currently, other data on forest stock are also available, but their accuracy needs further check. According to the FAO's 2005 Global Forest Resources Assessment, the forest cover of Armenia, as of 01.01.2005, was estimated at 282 thousand ha., with the total stock amounting to 36.3 mln. m³.

According to another source – results of "Economic Research on Armenia's Forestry and Wood Processing Sector" ordered by OSCE and conducted by "Economy and Values" research center – the forest cover area in Armenia (see Map 1) in 2006 made up 232 000 ha., with the timber-stock estimated at 28 mln. m³.

Forestry-planning works conducted in recent years indicate that the forest cover area of the mentioned territories is 188827 ha., with the total stock amounting to 27 mln. m³ (see the Table 3). If we supplement this with the data on the remaining forest enterprises in the north of Armenia, whose total forest cover area, according to the preliminary studies of the "Forest Research-Experimental Center" SNCO of the Ministry of Nature Protection of Armenia, makes 55000 ha., with the minimum volume of total stock estimated at 7 mln. m³, we'll arrive at the following data for the north of Armenia: 243.8 thousand ha. of forest cover area and 34 mln. m³ of total stock.

On the whole, the inconsistency between the results of assessment of forest cover and timber-stock is due to the difference in methods applied in different time periods, the quality of works performed and the absence of data on regular stock-taking of forests. Formerly, the forest assessment data were normally acquired through approximate estimation methods. Nowadays, the data on forest stock have become more reliable due to the widely used GIS and satellite images analysis methods, combined with field assessment reports.

Table 3 New forest management plans, 2005-2007

#	Planning area	Forest cover area, ha.	Total stock, m ³
1	Artsvaberd forestry	39495	6684950
2	Ijevan forestry	20956	2991740
3	Sevkar forestry	18240	3673170
4	Tchambarak forestry	6643	953210
5	Gugark forestry	21730	2436560
6	Noyemberyan forestry	27136	4585940
7	Goris forestry	12817	1353150
8	"Sevan" national park	13000	541390
9	"Dilijan" national park	24679	3586869
10	"Khosrov forest" state reserve	4134	200.000
	Total	188827	27006979

Due to nature-climatic and anthropogenic factors, the forest cover in Armenia has significantly diminished and currently is not equally distributed. 62% of forest area is in the northern regions of Armenia, 36% - in the south, and 2% - in the central regions.

According to the official information (“Hayantar” SNCO), the average efficiency of the country’s forests is estimated at III-6 of site index (*bonitet*), the average density is 0.55, the average timber-stock is approx. $\sim 125\text{m}^3/\text{ha.}$, the average annual increment – approx. $\sim 1.3\text{m}^3/\text{ha.}$ The timber-stock volume per one person approximates 12m^3 . Forests are mainly located on steep, extremely indented mountain slopes, at the height of 550-2400 m above the sea level. Forest zones are mainly located on areas with temperate climate, dense water-graphic systems and indented relief.

Armenia’s geographic location and mountainous relief contributed to the formation of rich biodiversity and a high degree of endemism. The number of types of forest communities is over 200. The forest areas have 274 species of trees and bushes, including main natural forest-forming species – *Fagus orientalis*, *Quercus iberica*, *Quercus macranthera*, *Carpinus betulus*, *Carpinus orientalis* and *Pinus kochiana*. These species cover 89.1% of Armenia’s total forest cover area and 97.2% of total wood-stock. Other tree species – birch, elm, maple, ash, pear tree, apple-tree, yew, hazel, plain, walnut, and others are mainly represented together with forest-forming species and cover 8.4% of the forest cover area.

Beech forests are spread at the height of 800-2000 m above the sea level and mainly occupy mountain slopes of northern location. Mere beech forests are centralized on the height of 1000-1800 m. In the mixed type of beech forests, the accompanying tree species are: oak, ash, elm, lime, hornbeam, maple, etc. Oak woods are characterized by complex and varied typological composition. They occupy spotlit slopes of southern location and are centralized at the height of 600-2200 m. The constituent part of the country’s forests is made by pine forests where the secondary species are represented by hornbeam, oak, and, occasionally, beeches. There are also artificial seedlings of pines, where the plant forming species is the *Pinus silvestris*. At the height of 1900-2300 m, mostly mixed, low-density sub-alpine sparse forests are represented. Here the forest-forming species are: *Betula litvinovii*, *Acer trautvetteri* and *Sorbus aucuparia*. The spotlit open forests of juniper are formed mainly from the following two species: *Juniperus polycarpus* and *J. foetidissima*.

The present report includes the following criteria for the forest sector vulnerability assessment: soil erosion, sanitary condition of forests, vulnerability to pests and fires, reproduction potential.

Vulnerability to aridity, erosion. In separate sections of forest lands and their adjacent territories instability of ecosystems can be observed. There is also an increase of whirlwind-fallen and snow-fallen territories, activation of land-slides, ditch mud-flows, erosion and flood, damping of springs, dust clouds formation and other phenomena, which will be activated still more, together with the increase of aridity due to climate change.

Measures:

- implement forest rehabilitation/afforestation (reforestation) measures on forest land sectors and steep mountain slopes; and
- preference should be given to afforestation (reforestation) of the bottom forest belt and southern location mountain slopes, as well as territories affected by erosion.

Sanitary condition of forests, vulnerability to pests and fires. Armenia’s forest stock degradation factors also include pests, diseases, and increase of fire threat. Non-regulated forest-felling, exploitation of cut-blocks, violation of forest-felling rules brings about change of climate conditions in forests, deterioration of sanitary conditions (high temperature, abundant light, fall of tree branches, leaves and woods as a result of forest-felling), as well as increase of fire threat.

These are favorable conditions for the mass spreading of pest insects and diseases, extension of nidus of infection, as well as fires. This phenomenon can be more intensely observed in the dry-tolerant open forests of central and southern parts of Armenia, as well as natural pine forests. In particular, some forest locations in Aragatsotn, Hrazdan, Kotayk, Vayk, Jermuk and Meghri regions are on the verge of drying-out and require continuous forest-protective and anti-fire measures. In case of forecasted climate change scenarios, forests of southern location in the whole forest area of Armenia, as well as the bottom forest belt will be most vulnerable to activation of phyllophagous pests, extension of nidi of diseases and fire threats.

In the recent years active forest-protective measures have been implemented (see the Table 4), but still there is a lack of special forest-pathological studies and monitoring data on pests and diseases spreading induces. Prior to implementation of forest-protective and anti-fire measures (see the Table 5), integrated forest-protective management plans need to be developed and ecologically safe technologies have to be applied. The statistics on anti-fire measures indicates that the frequency of fires is more intensive in dry-tolerant, open forests of the central and southern parts of Armenia (see the Table 6).

Measures:

- perform, on a regular basis, forest-pathological studies;
- apply anti-pest, anti-disease environmentally safe technologies;
- assess the level of fire threat in the territories, the likelihood of their occurrence and intensity, maintain statistics;
- establish specialized forest fire service;
- improve the sanitary condition of forests through involving forest-neighboring communities in the cleaning-works and providing fuel wood as a compensation;
- sanitary felling should be done on the basis of forest-pathological studies only.

Table 4. Forest protection measures performed by “Hayantar” SNCO

Aviation chemical fight measures against forest phyllophagous pests			
<i>spring of 2007 (ha.)</i>		<i>2006 (ha.)</i>	
Lori marz	5 600	Syunik marz	8 854
Tavush marz	4 424	Vayotz Dzor marz	5 300
Vayotz Dzor marz	2 054	Aragatsotn marz	2 904
Aragatsotn marz	3 200 ha.	Kotayk marz	2 737
Kotayk marz	2 000		
Syunik marz	7 445		
Total	24723	Total	19795

Table 5. Main required anti-fire measures

1.	Preventive measures
2.	Consultations in forest-neighboring communities
3.	Permanent indication boards in fire-risky zones
4.	Separation of resting and smoking places
5.	Information from mass media
6.	Construction of anti-fire belt-zones, mineralized belt-zones and pools
7.	Construction and repair of anti-fire roads
8.	Purchase of anti-fire equipment
9.	Formation and training of fire pump groups

Table 6. Forest fires in Armenia, 2006 (“Hayantar” SNCO)

#	Names of forestry enterprise branches	Number of fire cases registered	Total area fired, ha.	Including	
				forest cover. ha.	non-forest cover ha.
1.	Meghri	2	193,0	192,0	1,0
2.	Kapan	1	120,0	90,0	30,0
3.	Goris	1	10,3	7,3	3,0
4.	Jermuk	1	0,06	-	0,06
5.	Lalvar	1	3,0	3,0	-
6.	Yerevan	3	5,6	5,3	0,3
7.	Gugark	1	1,6	1,6	-
Total		10	333,56	299,2	34,36

Reproduction potential. Reproduction potential, from the point of view of climate change, is the indicator of forest ecosystems adaptation. In case of forecasted climate change scenario (rise of temperature by 2-3°C and decrease of precipitation by 10%), the adaptation level of meso-xerophile homogenous forest ecosystems will be significantly low. However, more than 70% of natural forests in Armenia is composed of the mixed stands where different types of trees create communities most resilient to external irritants, with a high level of adaptation to climate change.

Due to the forecasted climate change, the horizontal borders of forests will change and shift upwards, conditions for forest growth and reproduction will improve on the upper belt of forests. In mesophile regions the favorable conditions for forest growth and forest seed reproduction will be preserved on the bottom and medium belts, while on the upper (top) belt the rise of temperature by 2° will bring to improvement of presently observed unfavorable conditions. In north-eastern regions of the country the upper edge of forests at northern location slopes will probably rise by 150-180 m. On areas with continental climate conditions the change of air temperature and amount of precipitation forecasted for the bottom edge of forests will deteriorate forest growth and self-reproduction conditions and will subsequently shift up the forest’s bottom edge. A more arid climate forecasted for the central and southern forest zones with continental climate and southern location slopes of the zones with temperate climate will have a negative impact on natural seed reproduction of oak communities on the bottom belt of forests, will bring

to xerophytization of the species composition and will move upwards the bottom belt of forests. Insufficient forest growth conditions will be formed in arid forests of Vayq, Meghri and central part of Armenia, causing their gradual disappearance, while the bottom and top borders of the open forests will shift up by 150-200 m.

Measures:

- afforestation/reforestation measures should be reinforced with actions contributive to natural growth;
- on areas where natural growth is ensured, perform fencing measures, ensure self-seeding;
- improve the composition and structure of forests;
- implement complex measures to ensure optimal forestation of areas.

Vulnerable forest areas in Armenia

According to researches conducted within the framework of the First National Communication “Armenia – Country Study on Climate Change”, the territory of Armenia includes the following most vulnerable areas:

- vulnerability to aridity, erosion – Ararat hollow, Vayotz Dzor, Syunik and Tavush (high indices of erosion);
- sanitary condition of forests, vulnerability to pests and fires – mountain slopes of southern location (xerophytization, shift up of open dry-tolerant forests, extension of pests spreading nidi, increase of fire risk);
- vulnerability of reproduction potential – the bottom forest belt of central and southern parts of Armenia (deterioration of conditions for seed reproduction, shift of the belt upwards).

Forest rehabilitation

In the recent years the non-efficient use of forest stock has contributed to degradation of natural resources and subsequent increase of poverty. Due to a variety of factors and further formation of unfavorable conditions for the seed self-reproduction of the two main forest-forming species in the country, i.e. oak and beech, the latter are frequently replaced by ecologically more viable species of hornbeam.

Presently, there’s an increase in the volume of forest rehabilitation works performed by “Hayantar” SNCO’s forest enterprises (see the Tables 7, 8). On the whole, the volume of afforestation (reforestation) and forest rehabilitation works performed in the forest lands of Armenia in 2004-2006 made up around 16 000 ha. In 2006 the organization performed forest recovery works on the area of 9460 ha. The irrigation network is rehabilitated/constructed, and fencing works are performed as needed. Similar works are also performed by non-government organizations, within the framework of various projects on community development. Thereafter, it is important to implement forest plantations maintenance works.

However, intensive exploitation has brought about decrease of high-value forest areas and their transformation to low-value stands, losses in natural growth productivity, appearance of sparse forests and clearings, economic devaluation of forests and decrease of CO₂ absorption from the atmosphere. This requires complex forest recovery measures, creation of new forest areas, establishment and recovery of field protective forest layers. It is extremely important to use the

aborigine species during the forest recovery process, which will contribute to the recovery of ecological balance of the areas. It is also important, in ex-situ conditions, to preserve the forest variety in botanical gardens and zoological parks, dendro-parks and other “green” zones, which will benefit to preservation and reproduction of indigenous flora representatives, rare and endangered, endemic and relict species.

Improved functioning of planting services is of vital importance to the recovery of forest areas and implementation of forestation works in the republic. Presently, the significant number of planting services included in the structure of state forestry bodies, are not functioning, while the remaining ones are functioning within 15 to 20 per cent of their capacity. There is also a decrease in the variety of plantings, which currently does not exceed 10-15 species. The amount of conserved forest seeds and planting stock is still insufficient. Till 990s, 40-50 mln. seed plants and saplings were being planted through the above mentioned state system. They had a rich variety of around 60 species (currently, it does not exceed 10-15). The grown plantings accounted towards forestation and forest recovery works in the republic (6-7 thousand ha. per annum).

Priorities:

- extension and development of planting enterprises (services);
- establishment of forest seed laboratory;
- re-training of labor workers in communities;
- implementation of forest recovery projects in communities;
- use of indigenous species during forest rehabilitation for the purpose of recovery of ecological balance of the areas;
- use of environmentally safe technologies (non-waste technologies, etc.)

Table 7. Annual costs of “Hayantar” SNCO for 2006, as per types of activities

#	Activity	Cost (thousands dram)
1.	I. Preservation (current costs)	927295
2.	II. Protection (current costs)	529.2
3.	Forest pathological researches	381.0
4.	On-ground fight	148.2
5.	Payment for aviation services	-
6.	III. Reproduction (capital costs)	294423
7.	IV. Forest enterprises	240233
8.	Total	1462480 thous.

Table 8. Volumes of forest recovery and forestation works performed (1998-2006), in ha.

#	Name of the work	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
1.	Sowing of forest cultures	69.0	5.7	70.0	27.0	23.0	48.0	61.6	57.5	43.0	404.8
2.	Planting of forest cultures	344.2	290.0	317.0	246.0	212.0	211.7	521.9	465.0	278.0	2885.8
3.	Support to natural growth (through mineralization)	852.0	440.0	425.0	750.0	450.0	412.0	411.0	2435.0	2000.0	8175.0
4.	Preservation of natural growth (through fencing)	-	-	-	-	-	-	-	-	5000.0	5000.0
5.	Support of trunk-and-branch growth (increase)	-	12.0	5.0	109.0	-	44.0	1648.3	1115.2	2107.0	5040.5
	Total	1265.2	747.7	817.0	1132.0	685.0	715.7	2642.8	4072.7	9428.0	21506.1

Fig 1. Forest cover of Armenia, according to the satellite images, Landsat, 2006

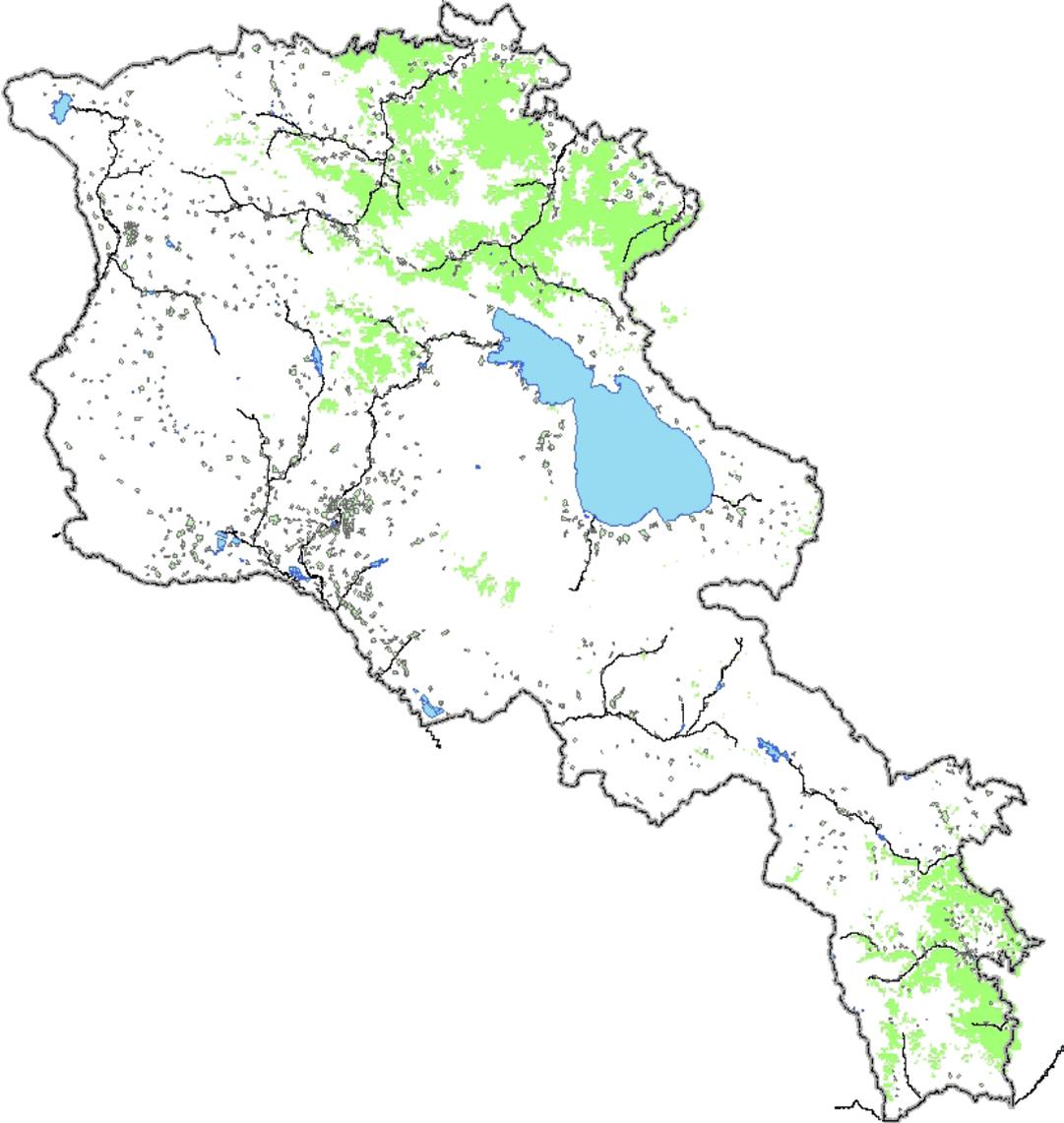


Fig 2. Forest areas having management plans

