

FOREST ECOSYSTEMS IN REPUBLIC OF MOLDOVA: EVOLUTION, PROBLEMS AND SOLUTIONS

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Key words: forest ecosystems, forests, evolution, status, age and development.

Abstract. This paper describes the findings of the state, evolution and management of forest ecosystems in the Republic of Moldova during the 200 years. In the complex study and analysis of the current situation are presented the basic characteristics of forest ecosystems and their role in environment protection, preservation and conservation of biological diversity and in the national economy, human welfare, etc. The basics of forest management activities and problems over the years and the major tasks to ensure sustainable development of forest ecosystems are tackled. The final part of the paper includes some conclusions and proposals on the sustainable development of forests in the Republic of Moldova in accordance with European and international requirements..

Introduction

Enormous changes that have occurred over the past 100 years on Earth were reflected on all aspects and forms of life on our planet. They show very sharply during the past 20 years through enormous changes in climate, environment, social and economic life etc. (GEO4, 2004).

The natural environment of the Republic of Moldova is, in general aspects, favorable for life. Biological Diversity (State of the Environment in Republic of Moldova, 2007) in the country is conditioned by its geographical position at the crossroads of three biogeographical regions: *Central European* represented by the Codry's Central Plateau (54.13% or 18300 km² of the territory republic), *Eurasian* - represented by forest steppe and steppe regions (30.28% or 10230 km²), *Mediterranean* - represented by regions of xerophyte steppe of the southern part (15.59% or 5 270 km²). In terms of fauna, the Republic of Moldova borders the Balkan region and forms a transition zone between fauna elements of continental Asian steppe and of European forest steppe. In the past biological diversity in the Republic of Moldova was well developed and only forest ecosystems covered about 30%, and according to some opinions they reached to 70% of land area (Pădurea - rădăcina sufletului, 1992). Currently the situation in the country is

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different: all natural ecosystems (forest, water, steppe etc.) are very fragmented and modified, and cover a total about 15% of country's territory.

Currently the Republic of Moldova is in the category of the states with a low forest cover. At the end of first decade of XXI century the total area National Forest Fund (FF) was estimated according to statistics, to about 440,000 hectares, equivalent to about 13% of the territory and the area covered by forests, according to the Land Cadastre – 396700 ha or 11.7% of the land (Cadastrul funciar al Republicii Moldova, 2002-2008), which represents a very small hint compared to the EU average (29%) or to countries in the same biogeographical region - Romania (28%), Bulgaria (35%) and Hungary (19.5%).

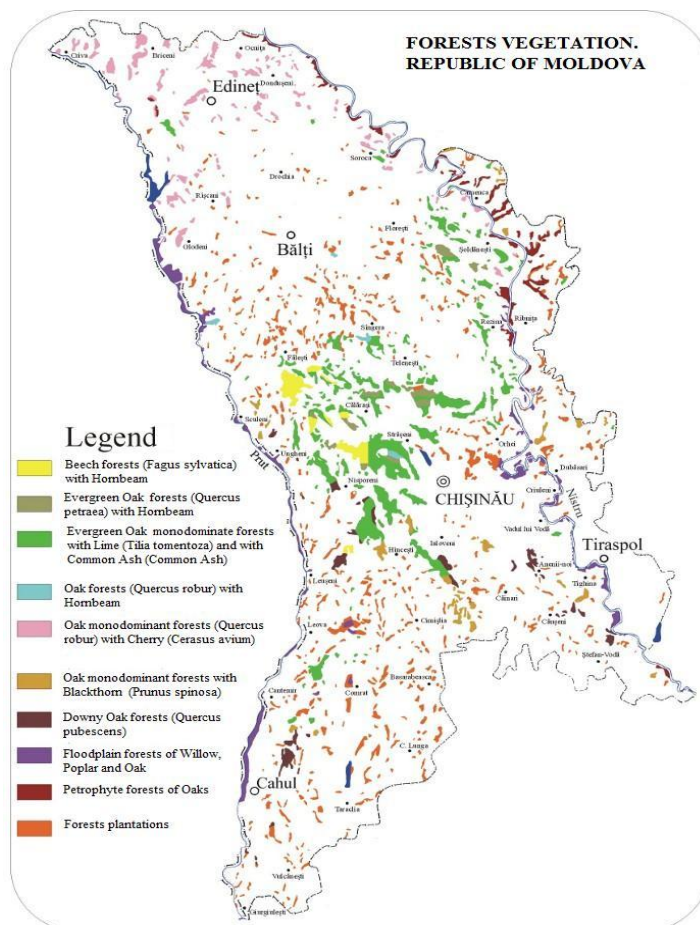


Fig. 1 - Map of Forest vegetation

In the present the biodiversity of the Republic of Moldova is specific and fragmented, of about 5600 species of plants, including about 2000 species of higher plants and about 17,000 species of fauna from which 16,500 are invertebrate species (Lumea animală a Moldovei, 2007).

In general the forests ecosystem evolution on the Republic of Moldova territory, because of climate interference (Central European, Balkan-Mediterranean and Eastern Europe) and of a protected landscape, has been very beneficial, especially during periods of lack of significant impact from the human population. At the present moment the forests do not form a continuous forest area, which traverse the whole country, but they are grouped into about 800 bodies of forest with surface from 5 to 1500 ha (Fig. 1).

Afforestation varies in different geographical zone of the Republic of Moldova: 8.1% in the north, 14.5% in the center and 7.7% in the south. Codry's region has the highest concentration of forest vegetation (Starea mediului în Republica Moldova, 2007).

Currently within the forest fund, the ecosystems have a wide range, comprising 28 biogeocenotic types and subtypes (according to the degree of productivity). A number of woody species are found on limit to the area in Moldova today: Beech, Evergreen oak, Lime, species of Central European origin who occupy the eastern edge of the geographic area, then Downy Oak, Balkan Pontic species, which occur in the northeast edge of the area. In the same situations are species of *Carpinus*, *Euonimus*, *Prunus* etc. (Bindiu, 1992).

This paper is intended to approach the problems of forest ecosystems development and in particular, the perpetuation and preservation of their biological diversity. The problems are particularly acute in the Republic of Moldova, a country with high human population density and predominantly agrarian economy, with strong traditions in agriculture.

1. Research methods

The research implied the consultation of various archive, statistical and bibliographic data with many facts and figures on the development of forested areas in space and time. Attention was drawn mainly by the integrated information in this domain over about 200 years; forest territories development; bio- and ecological features of plants from forest ecosystems and major factors impact upon them.

2. Important tabs in the history and evolution of forest ecosystems

Geographical, geological features, topography and climate have contributed to the rich and diverse natural vegetation of the Republic of Moldova. Deforestation

and burning of forests by human population was often an unwanted phenomenon, but the nature of these actions was different: human settlement, wars, colonization, poor management etc.

Table 1. The dynamics of the forests in the years 1848-1966

| Years | Forest area, thou. ha |
|-------|-----------------------|
| 1848 | 366,2 |
| 1861 | 330,8 |
| 1875 | 305,2 |
| 1893 | 286,0 |
| 1914 | 249,4 |
| 1918 | 230,0 |
| 1966 | 306,1 |

Table 2. Development indicators of forest ecosystem area.

| Years | NF forest area, thous. hectares | | Forests areas of first group, thous. hectares | | Land afforestation degree, % |
|-------|---------------------------------|-----------------------------------|---|-----------------------------------|------------------------------|
| | Total | Including: area covered by forest | | Including: Forests of green areas | |
| 1985 | 386 | 301 | 372 | 102,9 | 8,9 |
| 1990 | 407 | 340 | 407 | 119 | 10,2 |
| 1995 | 448 | 370 | 448 | 132 | 11 |
| 2000 | 489 | 410 | 489 | 146 | 12,1 |
| 2005 | 530 | 450 | 530 | 160 | 13,3 |

It is known that in the 14th-16th centuries, during the fighting with the Tatars and Turks, the burning and logging was widely used in national defense. Later, in the 17-20th centuries, when this territory was then subject to the Turkish and then the Russian empires, the exploitation of forests became more severe and unforgiving. Only in the twentieth century to the present have started some activities to halt total deforestation and restore the green cover, especially forests.

According to a complex study presented in the book "Леса Молдавии"

(Тышкевич, Бордюга, 1973), we can find the following: in the 19th century the forests of this area were used to build ships. For example, during the Russo-Turkish War (1806-1812), in accordance with the decree of year 1803 for the construction of ships, the Black Sea fleet was asking annually for 10802 secular oaks (Врангель В. История лесного хозяйства Российской империи. Санкт-Петербург, 1841, quoted by Targon, 2008). Another example is the March 1810 report of master Tarusov to head of Russian military administration on the selection from the forests of Orhei Codry “of 15000 trees of oaks good for ships and frigates” (Тышкевич, Бордюга, 1973).

Studies have shown that the forests in this area decreased from 1848 to 1918 with over 130 000 ha (Table 1), and the afforestation according to the Ministry of Agriculture and State Property (Book "О лесах России", СПб., 1900) by the year 1900 was only 6% (quoted by Тышкевич, Бордюга (1973). Also this study states that during the period from 1944 to 1971 inclusive, were created more than 120 thou. ha of forest cultures, including protective strips on 78400 ha. In the chapter "Forest resources and organizational structure of farm forestry in the MSSR" it says that on 01.01.1966 the total area of forest with all the protective forest strips was equal to 306,100 ha, including State forest fund – 266,900 ha and forests of collective farms (Kolkhozes) – 39,200 ha. But the area covered by forests was 247,800 ha and the forest’s wood products reserve was calculated at over 20 million m³.

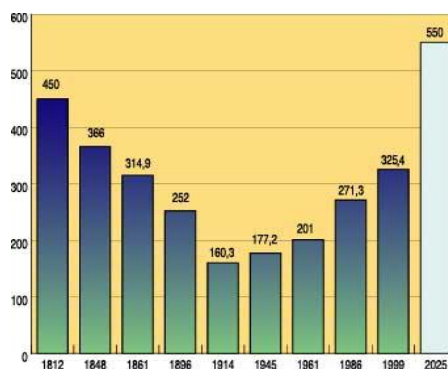


Fig. 2 - National Forest Fund dynamics and future objectives

The next source of information on the surface of forest ecosystems is a Complex long-term program of environmental protection and natural resource use in the Moldavian SSR in period until 2005 (Ecology - 2005), developed in the 80s

of the XX century. A sequence of this document is referring to forestry - pag.81 (Table 2).

After the declaration of independence of the Republic of Moldova in 1991, measures have been undertaken for the development of forest ecosystems, which have been included in various legislative-normative acts and documents of the state. As basic documents serve: National Strategic Action Program for Environmental Protection (1995), First National Report on Biological Diversity (2000), Biological Diversity Conservation National Strategy and Action Plan (2001), the Sustainable Development Strategy in Forestry Sector (Strategia dezvoltării durabile a sectorului forestier din Republica Moldova, 2001), Millennium Development Goals "Ensuring environmental sustainability" (Asigurarea Durabilității Mediului 2003) and others. According to the First National Report on Biological Diversity, Biological Diversity Conservation National Strategy and Action Plan, we have the following information regarding forest development and perspectives in Moldova for a period of 200 years (Fig. 2). As it can be seen from Figure 2, compared with 1812 forest ecosystems in the Dniester-Prut area decreased from 450,000 ha to 160,300 ha in 1914: practically been eliminated over two thirds of the forested area.

Cutting trees in large areas was practiced without taking measures to protect seedlings installed. In the years following areas of forest ecosystems have started to increase to 325,400 ha in 1999. As for the future objectives (year 2025) it is expected that the areas of these ecosystems will increase to 550 thou. ha.

Another document - Sustainable Development Strategy in Forestry Sector in Moldova, developed in 2001, provides for the extension of the areas covered by forest with at least 130 thou. ha, which allows to create: - new forest bodies, extending existing surfaces; - green islands of trees and shrubs; - the interconnection corridors between forested massifs; - protection curtains along the rivers, roads and around industrial facilities.

Many other materials available on this issue have been analyzed, but it was found that many data and sources don't have a true correlation. That's why we will refer only to some official statistics.

According to the data of the Land Cadastre of the Republic of Moldova, in 01.01.2010 the total area covered by forest vegetation was 462,700 ha or 13.7% of the country: forest fund – 410,200 ha (12.1%); surface covered with forests – 365,900 ha (10.8%); forest vegetation outside forest fund – 52,500 ha. It is obvious that the evolution of land covered with forests, afforestation degree and some of their structural features are specific for the Republic of Moldova (Tab.3).

In line with the Program "Ecology - 2005", the activities to increase the Forest Fund and forest planting have been done in parallel with the maintenance of forests. By virtue of historical events, USSR existed until 1991, so the performance

of the Program "Ecology - 2005", mentioned above, has failed. Mentioned Program provided that territory of Republic of Moldova to be afforested until 2005 by 13%, ecological norm being 27-30%. According to estimates made in 1994-1995, by 1994 only 38411 ha were planted, of which 13791 in the State Forest Fund and 18620 on land taken from other owners, for to achieve the figure of 450 thou. ha, was needed to be planted 154 thousand ha.

Table 3. Characteristic of forest fund of the Republic of Moldova*

| Year | Forest Fund / wooded land (Thou. ha) | Forest cover % of FF | Average age | Class production | Consistency | Wood volume | | Annual growth (m ³ /ha) |
|------------------|--------------------------------------|----------------------|-------------|------------------|-------------|----------------------------|--------------------|------------------------------------|
| | | | | | | total, mln. m ³ | m ³ /ha | |
| 1957 | 207,8/179,0 | 86 | 30 | 2,7 | 0,72 | 16,61 | 93 | 3,2 |
| 1985 | 322,8/271,3 | 84 | 40 | 2,3 | 0,73 | 33,53 | 124 | 3,3 |
| 1999 | 394,4/325,4 | 82,5 | 40 | 2,3 | 0,73 | 35,14 | 108 | 3,2 |
| 2005-2009 | 400,6/362,5 | 90,5 | 40 | 2,3 | 0,73 | 45,29 | 124 | 3,3 |

* Source: First National Report on Biological Diversity, 2000; Agenția pentru Silvicultură Moldsilva, 2010; Galupa, 2008.

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Afforestation degree is increasing over the last 60 years and the surface of forests over the years exceeds 80% of the land of the Forest Fund, which confirms the general development of Moldova's green carpet. To highlight some specific characteristics: median age of forests over many years is 40 years, consistency - 0.73 and class of production - 2.3, average annual growth is ranging between 3.2 and 3.3 m³ per hectare etc.

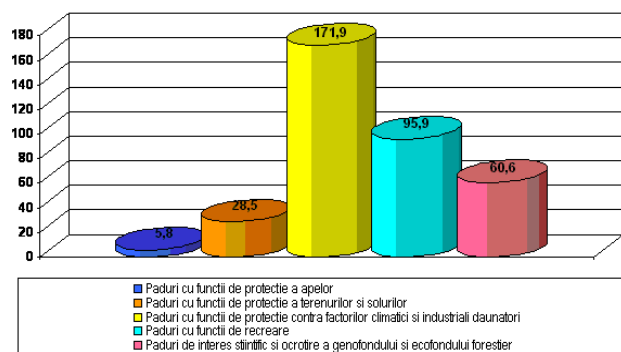


Fig. 3 - Forest structure in functional subgroup, ha
(Forestry Agency “Moldsilva”, 2010).

In accordance with the views of specialists (Pădurea – rădăcina sufletului, 1992, Forestry Agency “MoldSilva”, 2010) and legislation (Cocîrță, Clipa, 2008), the forests in the Republic of Moldova have exclusively environmental protection functions (class I) and is divided into the following functional categories (Fig. 3). Unfortunately, these features of the forests are not fully observed and forest resources are often misused to solve economic problems. According to the studies (Fourth National Report on Biological Diversity (2009), ICAS (2010), ecosystems from FF limits have the following forest types: Oak, downy oak, beech, water meadows and a number of variations thereof. In the forest ecosystems were identified 123 associations of which over 25 taxa of phytocenosis, which are valued as phytocenosis-standard.

According to the data source (Pădurea – rădăcina sufletului, 1992), of the approximately 40 species of trees and a series of about 60 bushes that grow larger and spread naturally in Moldova, we mention a few of those of trees more important in ecological and economic point of view (tab. 4).

In accordance with the data and biological properties, indigenous species in the past had an optimal evolution and age of most of them exceeded 100 years.

Species of oak (*Quercus*) and beech (*Fagus*) reach the age of 500 years (Pădurea – rădăcina sufletului, 1992), however, it can be meet oak specimens more older in Cobîlnea village (Șoldanești rayon), Căpriană (Strășeni rayon) and others. There is information that in some countries, specimens of oak reach the age of 700, 1200 and 1500 years (Wikipedia, Quercus). However, a great example, described in articles on *Tree of the Year in Romania* (Bătrânul Carpaților, 2011), is oak from Brasov county, called *Old of Carpathians* (Bătrânul Carpaților) or *Oak from Mercheasa* (Stejarul din Mercheasa), whose age exceeds 900 years.

Other species of trees, for example, from the genus *Acer* reach age 100 to 300 years, the genus *Tilia* (Lime) 200-250 years, respectively, of the genus *Salix* reach the age of circa 200 years (Wikipedia, Willow) etc.

| Table 4. The most important genus and species of trees in Moldova, the average age (years)* | | | |
|--|---|----------|-----|
| | Name | Code **) | Age |
| 1 | Beech – <i>Fagus sylvatica</i> L. | Fa | 96 |
| 2 | Genus Quercus L (Oaks): | St | 53 |
| | a) Oaks – <i>Quercus robur</i> L. | Go | |
| | b) Evergreen oak – <i>Quercus petraea</i> (Matt) Liebl. | Stp | |
| | c) Downy oak – <i>Quercus pubescens</i> Willd. | Str | |
| | Introducent: Red Oak - <i>Quercus rubra</i> L. | | |
| 3 | Genus Tilia L. (Lime): | Te | 52 |
| | a) Lime – <i>Tilia tomentosa</i> Moench., | Tep | |
| | b) Sulfur lime tree – <i>Tilia cordata</i> Mill. | Tem | |
| | c) Large linden tree – <i>Tilia platyphyllos</i> Scop. | | |
| 4 | Hornbeam – <i>Carpinus betulus</i> L. | Ca | 52 |
| 5 | Genus Fraxinus (Ash): Common Ash – <i>Fraxinus excelsior</i> L. | Fr | 52 |
| | Introducenti: Green ash (<i>F. viridis</i> Michx.) Fluffy ash (<i>F. pubescens</i> Lam.) | Frv | |
| 6 | Genus Acer L (Maples): Common maple – <i>Acer campestre</i> L. | Ju | 32 |
| | Field maple – <i>Acer platanoides</i> L., | Pa | 19 |
| Wood species of azonal type | | | |
| 9 | White willow – <i>Salix alba</i> | Saa | 27 |
| 10 | White poplar – <i>Populus alba</i> | Pl | 27 |
| | Aspen – <i>Populus tremula</i> , | Plt | 41 |
| Introducents of major importance | | | |
| 13 | Acacia (White) – <i>Robinia pseudacacia</i> L. | Sa | 12 |
| *) – Established in Moldova average age, years (Pădurea – rădăcina sufletului, 1992, Galupa, 2008). | | | |
| **) – Code in Romanian. | | | |

Currently the Republic of Moldova also has some very fragmented bodies of old forest, in our opinion, *normal or usual forest* of such territory, the majority being placed in reserve and is approximately 6000 ha, of which oak - 4900 ha, ash - 600 ha, beech - 300 ha, hornbeam - 100 ha (Galupa, 2008). În accordance with Law no. 1538-XIII of 02.24.1998 (with new amendments) on State Protected Areas

Fund, 4.65% of the Republic of Moldova's territory is protected areas, but the protection of forest ecosystems is only 18.8% of all protected areas. Also this law is stipulated that 433 old trees in all districts of the country are treated as *natural monuments*, subcategory C) Botanic point b) Trees secular /Annex 3 of the law /. Most of these old trees are of the genus *Quercus*, arguments in addition to its dominance in our forests.

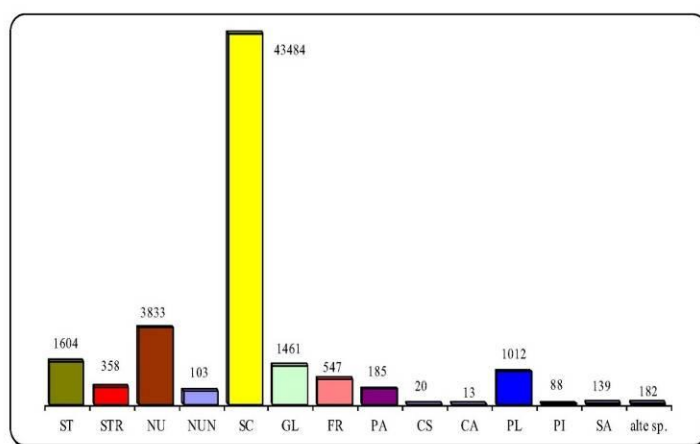


Fig. 4 - Information on forest expansion in Moldova during 2002-2008 (Galupa, 2009)

The much smaller number or a few units are represents other native and azonal species of trees and shrubs of the varios genera or families: Beech, Ash, Cherry, Maple, Planes, Poplar, Wild Pear, Pine, Lime (Linden), Elm, Hazelnut, Fir, Chestnut, Cedar, Mulberry, Douglas-fir, Glade, Osage-orange, Spruce, Mountain ash, European Hackberry. However, these old trees are true witnesses of the tragic events that happened or spend in the Prut - Dniester space with native forests, important of points of view biogeographic, ecological etc. This “de facto” means that now we don’t have in almost the normal native forests, which would be in optimal development, specific for each species.

In the XX century in forest ecosystems were continued the extensive exploration of native tree species that is confirmed by decreasing their surface and the high share of forests in the shoots. In case of *Qvercinee* that until the XIX century still represented the main tree species, in the next period is observed the essential decrease of its from 56.9% of total area in 1925 to 39.6% in 2006. The major changes also suffered other tree species such as the genera *Carpinus*, *Tilia* and *Fagus*: share of *Carpinus* surface was reduced from 11.4% in 1925 to 2.6% in

2006, of *Tilia* from 7.2% in 1925 to 0.9% in 1998, of *Fagus* from 1.2% in 1925 to 0.2% in 1998. In the same period has crucial increased the share of introduced species *Robinia pseudacacia* L. (genus Acacia) from 900 ha in 1925 to 131000 ha in 2006, or respectively from 0.4% to 36.1%. It has increased the surface of *Coniferous* species from 0.03% in 1995 to 2.1% in 2006. Some quantitative changes have trees species of ash, poplars and others (Fourth National Report on Biological Diversity, 2009).

As regarding the age of tree species in forest ecosystems, it currently ranging from 19 years at *Field maple* to 96 years at Beech ones, as well as the average age at the tree species in the Republic of Moldova is 40 years (see Tables 3 and 4).

In addition it should be take into account that in the current pedo-climatic conditions of the Republic of Moldova in the risk zone are found 512 endangered plant species, which constitute 27.4% of the total number. From all vascular plant species that are in the risk zone, most independent at current climate or dependent on region's weather conditions are plants from zonal forest ecosystem - 126 species (Fourth National Report on Biological Diversity, 2009). It is known that the losses of 20% of the total of biological species causes destruction of ecological balance, but the preservation of 10% of the natural ecosystems areas permit the conservation of 50% from all species (First National Report on Biological Diversity, 2000).

According to (Bindiu, 1992), the country's natural conditions with dominated by hills and plains and without mountains, the optimal afforestation grade is 25-30%. How far from this goal is the Republic of Moldova, it is demonstrated by analyzing the current and future activities.

6. Considerations on indigenous forest view

Perspective of forest ecosystems in the Republic of Moldova in terms of anthropogenic impact is determined mostly by:

- conducting of an environmental management in line with sustainable development of forestry strategy as part of National strategy of biological diversity conservation;
- environmental education and active participation of the people in addressing the forestry sustainable development.

However, the examples below show a different picture and a different perspective.

1. Activities to extend the forest cover in recent years and implementation of national strategies and programs, in 2002-2008 have resulted in increasing the surface area covered by forest with about 60 thou. ha, including 7100 ha in the Forest Fund and 53thou. ha in degraded land (Forestry Agency "Moldsilva", 2010, Galupa 2008, 2009). However, general spectrum analysis of planting activities in the years 2002-2008 shows us an amazing picture (Fig. 4): major and absolute

attention given to planting introduced species (SC - Acacia, GL - Glad, NU - Walnut, NUN - Black walnut), which together account for 48881 ha, as for the local forest species (ST - Oak, FR - Ash, CS - Cherry, etc..) - only 11,119 ha.

An important indicator of forest quality is compliance of stands to stationary growth conditions. It was established that about 40% of them do not meet the growth conditions, including: acacia - 52%, hornbeam - 8%, ash - 15%, other species - 20%. Most of stands are of vegetative origin: the shoots - 56.5% and 43.5% of the seed (Galupa 2008). One can safely assume that the following future activities to expand land will implement the same tactics of planting for the next 130 thousand ha - tasks established to run until 2020.

2. Logging is the main problem, which takes place within centuries in this territory. If the total clearing of forests in XIX century was a clear purpose, then currently the planned cuts and illegal raising are a concern over the fate of the general evolution of forest ecosystems. Analysis of data from the past 35 years shows that deforestation in recent years is increasing and in many cases exceeds the planting area (Statistical Yearbook of the Republic of Moldova, 2002, Moldova Statistics, 2010). An example might be the information of Government Decision no.1381 of 10.12.2007 on the activity of the Agency for Forestry "Moldsilva" in year 2006 and in nine months of 2007 (Monitorul Oficial, 2007): ... "In 2006 and nine months of 2007 were performed maintenance and care of existing forests on an area of 32126 ha, including: cutting care - 26309 ha; regeneration, conservation and ecological restoration cutting - 5092 ha; different cuts - 725 ha." The same document states: "In total, during 2002-2007 (spring), to achieve the above decisions were made planting works in an area of 45000 ha, including 39387 ha - on degraded lands in outside the forest fund and 5639 hectares - in its boundaries" (Note: disclosures we belong - PC). Here we should mention that what is planted does not have a full warranty on plants growth: depending on the circumstances and environmental factors a large number of seedlings (10-30%, in some cases even more), are cut or not reaching maturity, and what is cut can not be saved. A difficult problem is also illegal loggings which ignore the value of trees, but are quite frequent and large.

3. The impact of invasive species. In Moldova specific diversity of invasive species is of about 460 species, forming 43 communities from class *Festuceta*, *Brometa*, *Secalineta*, *Chenopodieta* and other (Fourth National Report on Biological Diversity, 2009). A great danger is backed invasion of acacia (*Rubinia pseudoacacia*), less of pine (*Pinus silvestris*), of spruce (*Picea abies*) and invasion of other species, which in addition to introduced species and those cultivated by man, occur independently by migration, transportation from other regions and/or infiltration in forest ecosystems. Since they are: American maple (*Acer negundo*), species of nettle (*Urtica*), hemp (*Cannabis*), orache (*Chenopodium* and *Atriplex* species), which increasing the secondary succession in ecosystems, contribute to

expanding the area occupied by synanthropic and aggressive species and by secondary phytocenosis with a reduced specific composition.

4. Forest vegetation pests and diseases. The total area of defoliation pest outbreaks is diverse and varies depending on the conditions and factors from 10000 to 100000 ha. In the past 15 years by pests are affected annually between 15 and 30% of forests (Raport tematic privind ecosistemele forestiere, 2002). There is a periodic change in the specific composition of outbreaks and in dominant species of defoliation pest.

5. Other sources of impact on forest ecosystems can be mentioned: illegal grazing, forest pollution with household waste, and tourism irregular. Generally, we note that the obvious increase in the flora of Moldova of the anthropofil element caused significant changes in the vegetal cover structure. Synanthropic species invasion into the degraded natural ecosystems impends the processes to restore natural biocenoses, especially forest ecosystems, and affect their functionality.

Conclusions and recommendations

1. All trees populations and forest associations, biocenoses and forest ecosystems generally have supported radical qualitative and quantitative changes through: defragmentation and impairment of the ability of natural reproduction, stimulation of the vegetative shoots development, reducing of diversity of the forms within dominant tree species, erosion of biodiversity in general within the invasion of alien species, persistent pests and diseases, anthropogenic pollution and others. However, in these conditions it makes impossible to connect to the international requirements for solving a basic task as it is "Protection of 50% of the most important areas in terms of plant diversity".

2. For to establish a true system of the forest patrimony preservation are need the cardinal efforts to expand local forest area at about 25% of the territory with the radical changes of the principles in environmental education, public participation in decision making and management in the relevant field.

3. Restoring the balance in forest ecosystems requires an urgent introduction of the priority principles to support the development of native species and their conservation at the biocenoses and ecosystems levels, the creation of a green carpet of native forests without fragmentation, and the promotion "de facto" of the sustainable development strategy in forest field of the Republic of Moldova.

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