CONSIDERATIONS ON FOREST ECOSYSTEMS EVOLUTION IN THE REPUBLIC OF MOLDOVA

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ABSTRACT:

Certain statistical data on forest ecosystems evolution in Republic of Moldova's territory in 200 years period are analyzed in the article.

The history of forest fund and ecosystems' development on the territory between Prut and Nistru Rivers and of data presentation methods during different periods of territories' social economical development is summarized. Forest ecosystems development issues in study and specifically those of forests' continuity and conservation are extremely important for Republic of Moldova, which is a country with high population density, old traditions in agricultural branch and with a major negative attitude towards biological diversity maintaining and forest ecosystems' viable development.

Goals and objectives of the present work are to analyze forest evolution and to identify higher priority issues in order to rectify the situation in forest sector in Republic of Moldova.

Basic characteristics of forest ecosystems are presented and causes of differences in data interpretation were described on the basis of statistical data study and analysis during different periods and from different sources, as well as maps dated 1910 and 2004. Certain basic elements of ecological management in forestry that exist in Republic of Moldova in present are described, such as legal normative base, infrastructure and others.

The final part of work contains conclusions and some suggestions on forest ecosystems' viable development in Republic of Moldova according to European and international requirements.

1. Introduction

Vast changes that occurred on Earth during last few decades had affected many aspects and life forms on our Planet. They are manifested quite perceptibly by enormous changes in climate, environment, social and economical life etc. Their direct consequences in many countries, as well as in Republic of Moldova, were economical and energetic crisis, environmental degradation, social deterioration, e.g. poverty, migration, abandoned children, etc. (Global Environmental Outlook, 2007).

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The natural environment of Republic of Moldova in general aspects is favourable for life. Biological diversity of Republic of Moldova is also conditioned (Republic of Moldova. State of the environment, 2007) by its position at three biogeographic interferences: *Central European*, represented by Codry Plateau (54.13% or 18.3 thousand km^2 of republic's territory); *Eurasian* – represented by forested steppe and steppe regions (30.28% or 10.23 thousand km^2); *Mediterranean* – represented by *xerophyte* forested steppe from Southern part (15.59% or 5.27 thousand km^2).

Biological diversity of Republic of Moldova on actual stage is specific and diversified, which constitutes nearly 5,600 of plant species, including circa 2,000 species of higher plants (*Embryophyta*) and about 17 thousands of fauna species, from which *Invertebrates* constitute 16.5 thousand species (Lumea animală a Moldovei, 2007).

It is known that loosing 20% of total biological species provokes ecological equilibrium destruction, and conserving 10% of natural ecosystems areas allows saving 50% of total species (First National Report on Biological Diversity, 2000).

Climate change is considered a problem („Nature 2000", 2007) that would seriously affect biodiversity. Species distribution's modelling data showed that 20-30% of species would disappear if the average annual temperature would rise by 1.5-2.5°C.

In the past, the republic's territory ample with biological diversity and only forested ecosystems covered nearly 30% of it (Pădurea – rădăcina sufletului, 1992). According to different sources (А. Защук, 1862; Н. Могилянский, 1913), pastures (steppe ecosystems) covered nearly half of total Basarabia's area (2200 thousand ha or 48.8%) in the beginning of XIX^{th} century. A big majority of grazing fields and hayfields was concentrated in Bugeac and Balti steppe regions.

According to the theoretical data from ecology („Fundamentals of Ecology", by P.E.Odum), forestation optimum for Planet's temperate zones is 30-40%, and life optimum for human society is accomplished at population density which allows allocating at least 2 ha for each individual, from which forest should constitute 0.8 ha (Pădurea – rădăcina sufletului, 1992). For Republic of Moldova's natural conditions, which is a country with hills and plains preponderance and which does not posses any mountains, this indicator should amount 25-30%.

In the present, the situation in Republic of Moldova is different, we have only 15-17% of total area covered by all kinds of natural ecosystems (forests, aquatic, steppe, etc.) altogether, which are heavily fragmented and modified, and impose urgent actions for territories' genetic and biologic potential recovery and sustainable ecological balance maintaining. Republic of Moldova falls into the category of countries with a reduced forestation degree. At the end of first decade of XXIst century total area covered with woods constitutes 365.2 thousand ha or 10.2% from territory. According to statistical data (Land Cadastre of Republic of Moldova, 2011), 30.8 thousand ha from wooded area are represented as protective forest strips, and 21.2 thousand ha are plantations of trees and bushes. Republic of Moldova's forestation average degree is very small when compared with neighbour countries. For example, in Romania – 29%, Bulgaria – 36%, Ukraine -

17% or Hungary – 23%, and European forestation average is 29%, (Global Forest Resources Assessment, 2010*)*.

In Republic of Moldova the system of legislative and normative acts on the environmental field (P. Cocirta, C. Clipa, 2008), including forest ones, which was elaborated and implemented during years of independence (20 legislative acts, 33 normative acts, 22 orders emitted by the Forest Agency "Moldsilva"), allows achieving theoretical forestation degree in question, though their implementation and practical performance is more difficult.

2. Several pages in history and evolution of forest ecosystems

Forest ecosystem was the first element of landscape that has suffered much because of human intervention. Massive reclamation of forest resources dates back to the XIV-XV centuries, as together with upward evolution of population number and new settlements construction, as well as with extensive agriculture development in conditions of feudal economy (D.Cantemir, 1988).

Two centuries ago, 30% of territory between Prut and Nistru was occupied by forest. Intense territorial exploitation by man led to environmental degradation and natural resources depletion. Deforestation and forests burning by human population was and still is a very undesirable phenomenon and quite frequent, but these actions reasons vary: human settlements, wars, colonization, poor management, etc.

It is known that in the XIV-XVI centuries, in times of war with Tatars and Turks, forests' burning and cutting has been practiced widely in state defence. Lately, in XVII-XX centuries, when this territory was in Turkish imperial dependency and then in Russian one, forests exploitation became even more intensive and ruthless.

1. Forest complex study presented in year 1965: „Tipi lesa i lesnie assoțiații moldavkoi S.S.R." (authors Geideman T., Ostapenko V.), shows that first forest inventories on the territory between Prut and Nistru were executed in 1809. Thus, towards 1812 Basarabia's forests area was estimated to be 547 thousand ha, and forestation degree was 12.1%.

Table 1. Forests area dynamics in years 1848 - 1966.

Years	Forests area, thousand of ha
1848	366.2
1861	330.8
1875	305.2
1893	286.0
1914	249.4
1918	230.0
1966	306.1

2. Complex study presented in book "Lesa Moldavii" (autors: Tișkevici G. L., Bordiuga V. G., 1973), reflects data and forest issues approaches for 120 years period. Studies executed in that times have shown that forests' area in this region has decreased from year 1848 and until 1918 by 130 thousand ha (table 1), and forestation according the Ministry of Agriculture and State Property data was only 6% of territory until 1900. The studies' materials indicate the following: in XIX century forests in this region have been used extensively for ships' construction. For example, we can mention that during Moldavian –Turkish war (1806-1812), 10,802 of secular oaks were demanded for ships' construction of Russian fleet on Black Sea according to 1803's decree of

the Russian Empire (Wrangheli V. Istoria lesnogo hozyaistva Rossiiskoi imperii. Sankt-Petersburg, 1841) – cited according to P. Targon (2008).

Another example is Tarusov's craftsman report to the head of Russian military administration about selection of „15,000 oaks good for ships and frigates" in Orhei's Codry (cited according to: Г. Тышкевич, В. Бордюга, 1973). Report is dated as March 1810 – it turns more than 200 years on the stage of finishing this article. Also in this study is stated that in period of years 1944 - 1971, inclusive, it was created more than 120 thousand ha of forest crops, 78.4 thousand ha from which has constitute the fields of protective green belts. In the chapter „Forest resources and organizational structure of forestry establishment in MSSR" of the work in question it is specified, for date of 01.01.1966, that total area of forest land with green protective belts was 306.1 thousand ha, including state forest land area – 266.9 thousand ha and kolkhoz (collective farm) forests area - 39.2 thousand ha. Thus, area covered with forests constituted only 247.8 thousand ha, and wood products' reserve was calculated to be over 20 millions m^3.

*3. Complex long-term programme „*Programul complex pe termen lung până în anul 2005" *("Ecologia - 2005"),* 1987. It was elaborated in 80s years of XXth century and states the following integrated data on forest ecosystems development indexes (page 81 of the Programme) presented in table 2. According to Programme "Ecologia – 2005", after 1985 the activities for Forest fund areas increasing and forestry crops planting continued and were executed together with activities of forest exploitation. Nevertheless, Programmes executing were aborted due to historical events.

Table 2. Forest ecosystems area's development indicators during 1985-2005 years.

Years	**National forest area, thousand ha**		**First group forests area, thousand ha**		**Country's forestation level, %**
	Total	including: area covered with woods	Total	including: forests from green zones	
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

Starting with Republic of Moldova's independence in 1991, forest politics have a specific character, keeping some traditional elements from former USSR and gradually accumulating international experience. The basic documents for forestry branch development in Republic of Moldova becomes: Strategic National Action Programme for Environmental Protection in the 1995-2010-2025 period; First National Report on Biological Diversity, 2000 and National Strategy and Action Plan for Biological Diversity Conservation, 2001; Sustainable Development Strategy for forestry sector in Republic of Moldova, 2001; Millennium development objectives for ecological security for 2007-2015; and others.

4. National Strategic Action Programme for Environmental Protection for 1995-2010-2025 period was elaborated in 1995. According estimations executed in years 1994-1995 during new Programme's elaboration, it was stated that only 38,411 ha were forested in 1986-1994 years - action period of „Ecologia 2005" Programme, among which 13,791 are in State Forest Fund (SFF) and 18,620 in terrains taken from other holders, and total area of SFF in 1994 has constituted 379.1 thousand ha, among which 317.6 thou ha were occupied by forested areas. Also, according to the same Programme, 40 thousand ha of protective green belts planting was contemplated in years 1986-2005. But until 1994 their area has been only 5,223 ha, which makes only 13% from the planned amount of works. In conclusion it was stated no perspective for to realize „Ecologia - 2005" Programme in time, even in conditions in which forested area until 2005 had to be in amount 450 thousand ha or 13%, or ecological norm is 27-30%. Within the framework of a new programme, terms of legislative normative acts' projects elaboration were stated together with National Action Plan for environmental protection for 1995-1997 and other documents, among which are also those for forestry branch development. The following basic activities were planned for the future period - 1995-2010-2025 years: elaboration of complex programme of ecological reconstruction and natural forest genetic fund restoration, which will essentially contribute to forest network after its realization. This programme was an essential start in work experience accumulation regarding legislative and normative domain and contributed substantially to forming a basis of environmental acts and documents (P. Cocirta, C. Clipa, 2008) appreciated on national and international level.

5. First National Report on Biological Diversity, 2000; National Strategy and Action Plan in Biological Diversity Conservation, 2001. These documents, elaborated in a special project, have a retrospective analysis on forest fund development and perspective in the Republic of Moldova for 190 years period. The estimations executed and presented in these documents shows the differences in forestry development evaluation (figure 1). As figure 1 show, forest area in Prut and Nistru interfluves has reduced from 450 thousand ha in year 1812 till 160.3 thousand ha in 1914. It is evident that massive forests cutting on large areas had been practiced in those years without concrete measures to protect their genetic fund. In the following years forest ecosystems areas began to grow until 325.4 thousand ha in 1999. But these ecosystems increase till 550 thousand ha were planned for future objectives.

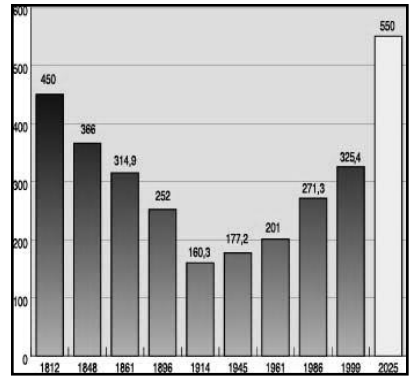


Fig. 1. National forest fund dynamics and future objectives.

6. Millennium development objectives, 2003 is an important document, that contains also a short retrospective analysis of forest ecosystems development, but official statistical data reflects only 1973-1988 years period. Forest fund areas increase from 343.6 thousand ha in year 1973 till 379.7 thousand ha in 1988 has

been evidenced during this period. Used data has been taken from official statistics of the Republic of Moldova.

7. Sustainable development strategy of forest sector in the Republic of Moldova, 2001, stipulates increasing of areas covered by wood vegetation by at least 130 thousand ha until year 2020, which would allow creating: - new forest bodies, extending areas of those that already exist; - green „islands" of trees and bushes; - linking corridors between wooded areas; - protective belts alongside the rivers, roads and around industrial objects.

3. Forest area. Summary data and results

Quantitative aspects. Thus on the basis of different bibliographical sources analysis and above-mentioned statistical data, an evolution of forested areas for the last 200 years can be reconstructed (figure 2). At the beginning of XXth century forests' area reached 239.5 thousand ha and forestation degree was equal to 6.9%. At the same period of time it was elaborated a special map (see Bassarabia's Hungarian map, 1910 at figure 3), which shows the general forestation level, as well as the fragmentation of the forest in territory. Starting with this period, first measures of wooded areas amelioration are taken. In the period of the country independence it was elaborated a new document - National Strategy in Biological Diversity Conservation in which forest funds' extension until 550 thousand ha is planned by year 2025 (figure 1, 2).

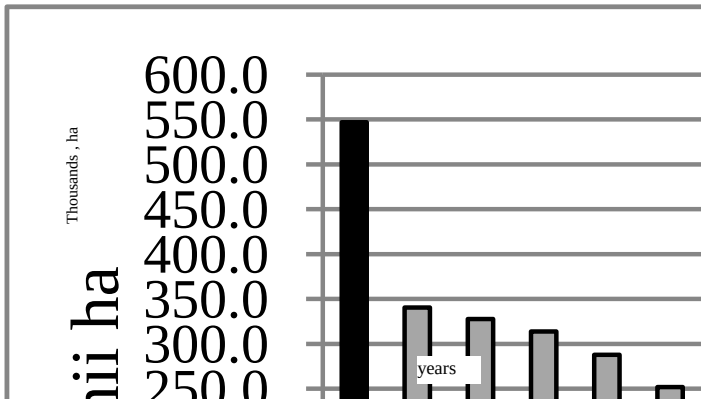
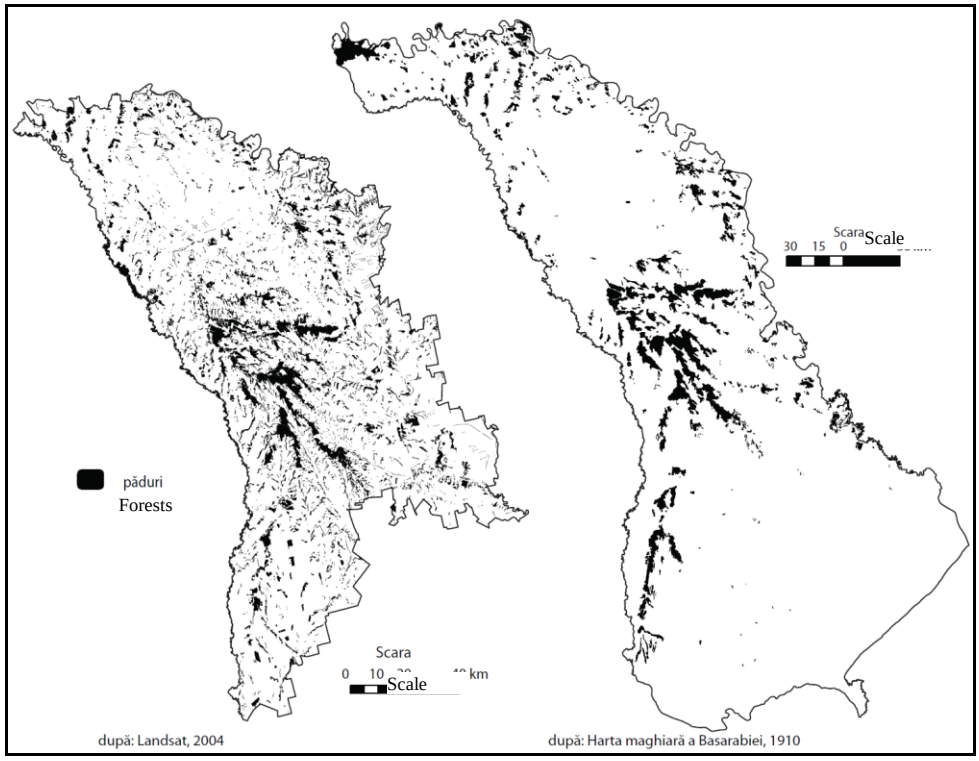


Fig. 2. Wooded areas' dynamics.

The present period of forestation level in Republic of Moldova differs much in spatial aspect (see Landsat image in figure 3), being a function depending on both natural and anthropic factors (figure 2 and 3). Forest landscapes, as a rule, are registered on 200-250 m heights (due to bigger precipitations amounts) and on more fragmented areas (as they are impossible for agricultural usage), where they occupy major surfaces. Among natural units, by a bigger forestation level, one can identify plateau regions: *Codry Plateau* – 25.7%, *Podolia Plateau* – 11.8%, *Tigheci Hills* – 11.6%, *Cogâlnic Middle Plateau* – 11.2%, *Nistru Plateau* – 11.0%.

Central Region's forests area reaches 201 thousand ha or 45.7% of total forests' area, their majority is concentrated in Codry Plateau – in Hâncesti (37.4 thousand ha), Straseni (26.1 thousand ha), Orhei (23.8 thousand ha) and Calarasi (22.7 thousand ha) districts. The high forest ratio is explained both by specific natural conditions (more fragmented relief, more humid climate), and by the reduced anthropic load. Forestation level in the region is equal to 20.1%, changing from 8.9% in Dubasari district to 35.8% in Straseni district, which is maximum value for republic. For the many parts of the region, forestation level exceeds national average by 2 (Hincesti and Nisporeni) or 3 (Straseni and Calarasi) times.

North region contains 109.5 thousand ha or 24.9% from total forests area. Forestation level in the region is small – 9.7% and only in some places exceeds republic's average (districts Soldanesti – 18.8%, Rezina – 15.5% and Ocnita – 13.3%). Low forests' ratio is characteristic for Balti Plains (less than 5%), thus identifying Drochia district in this aspect – 2.9% (absolute minimum). Balti Plains is also featured by the highest level of agricultural usage of territory, most low altitudes and most arid climatic conditions, that's why forest area is most reduced.



Source: Source: Bassarabia's Hungarian map, 1910

Fig. 3. Forest areas evolution according some cartographical sources.

South region's forest occupy 100 thousand ha or 20.8% from their total area. A more increased forestation level is characteristic for Tigheci Hills

(districts Cantemir and Leova – 14.1% each), which have high and fragmented relief, and also more favorable climatic conditions for this category of terrains. The part from Nistru's left bank is featured by lowest forestation level (8.8%), caused by natural specifics (more arid climate, more low altitudes), and also higher ratio of agricultural terrains.

Forestation level differs greatly among the communes (from 0/1% in Crasnoe town till 77.9% in Capriana commune). The highest forests ratio is registered in Codry Plateau communes, partly in Nistru Plateau and Moldova de Nord Plateau, within their limits the relief is usually more fragmented. The majority of forests in these regions have the reservations status and are under state protection. Forestation levels' minimum values are specific for communes with higher ratio of agricultural regions from Cubolta and Nistrul Inferior Plains for which forests are not typical in spontaneous conditions.

In general we can state that in last the two centuries forest landscapes suffered essential modifications. During this period initial forest areas have been diminished by 2.8 times (until 1940), afterwards an increase in 2 times is registered (until 2010). Forestation level in republic is by 2.3 times less than world average and nearly 3 times lower than European one.

Qualitative aspects. Along with quantitative modifications there were also changes in forest landscapes quality (figure 3): forest bodies were crumbled, species composition is worsening, natural secular woods ratio is diminishing, and forests resources area per capita is also diminishing substantially. Forestation level caused by wood network planting upgraded agriculture as well as landscapes ecological balance's maintaining. But actual forestation level is still insufficient for landscapes' ecological stability assurance. For this, forests ratio in total territorial fund should exceed one quarter from country's territory (Volkov S., Hlistun V., Uliukaev V., 1992).

Forest network plays a special role in ecological state amelioration. Along with their ecological importance, forest networks have also substantial economic role, contributing to agricultural productivity increase by nearly 15% (*Lesnie zaşitnie nasajdeniea*, 1963).

According to scientists, specialists and present legislation opinion (Pădurea – rădăcina sufletului, 1992; Forest Agency Moldsilva, 2010; P. Cocirta, C. Clipa, 2008), Republic of Moldova's woods have exclusively environmental protection functions (I class) and fall into the following functional

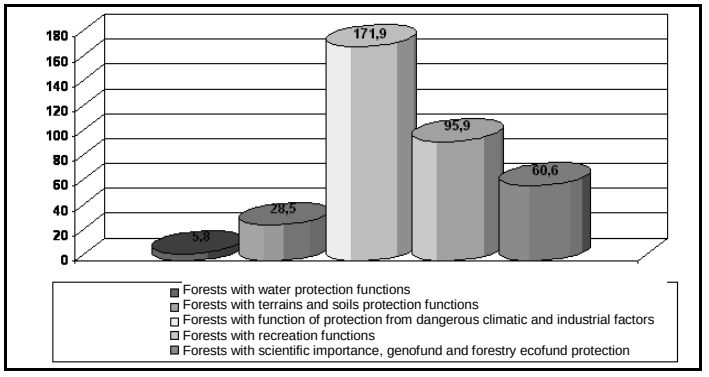


Fig. 4. Forests structure by functional subgroups, thousand ha (Forest Agency Moldsilva , 2010).

categories (figure 4). Unfortunately, these forests particularities are not respected and sometimes are used for economical issues solving.

Forests species composition was and still is a serious disadvantage of forested areas extension (table 3), as those with small growing period are preferred that are not always fit for local conditions (locust, poplar, pine, etc.).
Trees species quality and ratio analysis in forested ecosystems showed us that during last 200 years a significant change took place not only in specific and numeric of basic trees, but also of environmental quality. If forested areas were reduced by total deforestation in XIX century, than changes in forests quality and environment, in general, for these ecosystems took place in XX.

Table 3. Spatial evolution of dominant species of trees in 1925-2006 period.

Dominant species	**Year 1925**		**Year 2006**	
	thousand ha	**% from total**	**thousand ha**	**% from total**
Oak (*Quercus robur*)/ Planting out, %	119,1	56,9	143,8	39,6
Locust (*Robinia*)	0,9	0,4	131,0	36,1
Ashtree (*Fraxinus*)	12,5	6,0	16,6	4,6
Hornbeam (*Carpinus betulus*)	23,9	11,4	9,4	2,6
Poplar (*Populus*)	12,7	6,1	5,7	1,6
Limetree (*Tilia*)	15,2	7,2		
Beech (*Fagus sylvatica*)	2,5	1,2		
Conifers	0,06	0,03	7,7	2,1
Area covered with woods	209,4		362,7	

Available data analysis shows, that by plans and state programmes and other local and national activities initiation and implementation, forested areas have grown in the 1925 – 2006 period, but also in this period forests' cover quality has decreased significantly (table 3).

General spectre analysis of planting activities in 2002-2006 (table 4) have revealed a major and absolute attention for introduced (invasive) species (pine, poplar, locust and others), a significant decrease of forest forming basic species such as for example oak.

Table 4. Planting executing timetable within „***Soils conservation in Moldova***" project (Forest Agency Moldsilva, 2010).

Years	**Pine**	**Poplar**	**Locust**	**Oaks**	**Total**
2002	9,9	267,2	4547,89	458	5282,99
2003	-	90,3	4375,61	624,24	5090,15
2004	-	43,55	4424,21	161,65	4629,41
2005	0,5	28,77	3807,16	425,59	4262,02
2006	8,4	14,1	966,49	35,93	1024,92
Total	**18,8**	**443,9**	**18121,36**	**1705,4**	**20289,49**

4. Conclusions

1. Accumulated materials generalization allows stating that independently of some diverging that can appear in numerical analysis of multi-source data, forest fund increasing in time is noticed in Republic of Moldova.
2. Concrete actions for entire forest space development are necessary, which can ensure biological safety and ecological balance of Republic of Moldova's territory.
3. Extension of state protected areas is imperative, and also to develop urgently the sustainable reproductive base for bigger number of plants and animals species, to prohibit illegitimate and uncontrolled cutting of native trees in native forest ecosystems. All actions measures should be done within control and participating of civil society and local public or individuals.
4. Protection of forest ecosystems is a broadly stated goal in the legislation of the country, but its compliance is poor. To install a real regime of forest patrimony conservation we need cardinal efforts with radical changes of principles regarding ecological education, public participation in decision-making and management in this field.
5. The importance of forest ecosystems on Earth is undeniable and crucial. Wooded areas extension according to international requirements is still possible in present too, in conditions of deep economical crisis. Nevertheless, new challenges and positive and permanent actions are needed for ecosystems potentials increasing, using new forms of business such as ecological tourism, pharmaceutical production, natural therapy - altogether and in all aspects being environmentally friendly and ensuring environmental sustainability.

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