

**CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE**

**Faculty of Forestry and Wood Science**



**Forest Fire Protection in the Republic of Moldova**

Bachelor Thesis

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**CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE**

## **Declaration**

I hereby declare that I have done this thesis entitled “*Forest Fire Protection in the Republic of Moldova*)” independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

.....

Lungu Daniel

## **Acknowledgements**

I would like to thank CZU for accommodating me and giving me the opportunity to study Forestry in English in one of the best cities in Central Europe, as well as the staff of FLD for helping me with all the problems I had during my study as a foreigner and there were definitely a lot of problems.

## **Abstract**

Forest fires are a phenomena which occurs all over the world because either because of natural causes such as lightning or anthropological causes, even though the majority of forest fires are caused by human activity. In most of the ecosystems around the globe, humans have changed the natural fire regimes by altering the intensity and frequency of the fires. This bachelor thesis deals with the particularities of the forest fire protection in Moldova, such as the classification of the fires, the methods and tactics of localization and extinguishing fires, the statistics in regards to the areas and intensity of these calamities as well as the causes of them. The particularities of forestry in Republic of Moldova have also been presented in this work, such as the geography, species composition, illegal activities etc. in order to create an objective and inclusive image of the situation in regards to the forest fires in the country.

Keywords: Moldova, forestry, forest fires, fire-fighting, protective equipment

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## **1.0 Introduction**

Forest fires are most often spontaneous, the triggering and evolution of which depends on a number of enabling factors, such as the condition and nature of the combustible material, proportion of living vegetation and dead plant material, composition, structure and density of the forest, degree of compaction of the dead matter etc. or the orographic and weather conditions, as well as the causal factors (natural and anthropogenic), and lastly, the preventive and extinguishing measures taken.

In recent years, climate warming has seen an increase in the duration and extent of the favorable weather conditions for forest fires. Republic of Moldova is no exception either, the territory being characterized by a high variability of the climate conditions, which have led over time to extremely dry or extremely rainy periods, which in turn have led to an increase in the number of forest fires and the damage they have caused, the most prominent examples are the droughts of the years 2007, which have caused an unprecedented level of damage from the forest fires – around 791 ha, 2012 – 672 ha, 2015- 352ha, 2017- 246 ha, 2019 – 204 ha (Taranu et al., 2021). Taking into account the weather phenomena caused by the persistence of high temperatures associated with the wind, which manifests itself at the arrival of the spring, the start of agricultural work on the land near the forest, the cleaning of the remaining lots of agricultural vegetation since the autumn, the beginning of the summer season, leaving of unextinguished fires and pyres or without supervision, creates extremely dangerous conditions for fires in the forests. More than 90% of forest fires in Moldova are caused by human negligence, especially in more dry times (Taranu et al.,2021). Foresters in the Republic of Moldova are concerned about the irresponsibility of persons who decide, for some reason, to set on dry vegetation within fields, forest strips, grazing land, or other areas with high fire risk. Even though 97,8% of the forests in Moldova are deciduous which are less affected by the crown fires, litter fires can still cause serious damages (Moldsilva Agency, 2020).

## **2.0 Aims of Thesis**

The main aims of the thesis is to describe the current state of forestry in Republic of Moldova in regards to forest fire protection and to asses subjective views on the development on the issue.



### **3.0 Methodology**

The thesis will be based on literary research. Moreover, based on the summary of the available literary sources, a subjective assessment will be made subsequently.

1 Forest district and 3 forest ranges have been visited in order to inspect the fire-fighting equipment available and the general situation with forest fires in that region.

## **4.0 Literature review**

### **4.1 Geographical information**

The Republic of Moldova is a small landlocked country with an area of 33,850 thousand km<sup>2</sup>, located in Southeast Europe, between Ukraine and Romania. Most of the country is located between two rivers, the Nistru and the Prut River, the last one forms the western border and joins the Danube on a small stretch of the Black Sea. Although most of the country is, hilly, the altitudes do not exceed 430 meters. (Boboc, 2009)

The Republic of Moldova is at the crossroads of three bio-geographical areas whose natural conditions have a decisive impact on the evolution of all the components of the environment: the centre is dominated by the Central Moldavian Plateau, with altitudes up until 400m and it is the Eastern boundary of the deciduous forests of the Central Europe; in the northern part of the country natural conditions are the western wing of the Silvo-steppe area, with altitudes up until 350m; and the southern part of the country is dominated by Steppe, with altitudes not exceeding 120m. (Boboc, 2009)

The Republic of Moldova has a moderate continental climate, the summers are hot and long, with average temperatures of about 20°C, and the winters are relatively light and dry, with average temperatures in January of -4°C. Annual rainfall, from around 600 mm in the north to 400 mm in the south, can vary widely, and dry periods are not unusual. Heavy rainfall usually falls in early summer and October, and heavy rains and storms are frequent (Mitchell et al., 2015). Due to the uneven nature of the land, the summer heavy rainfall often causes erosion and alluviation of rivers.

With rich Chernozem soils and a temperate climate, the Republic of Moldova has historically focused on agriculture. The land area is roughly divided into 91% rural and 9% urban area. Around 74% of the land is used for agricultural purposes (of which around 90% is privately owned). According to estimates, 73% of the land is arable, but only 12% is cultivated permanently. (Postolache et al., 2006)

## 4.2 Forest cover

The national Forest Fund (FFN) of the Republic of Moldova represents 13,6% of the total land area, or about 446 400 ha<sup>2</sup>. Around 379 300 ha of this area are land covered by forests, the rest is land for afforestation or for various administrative needs (Mitchell et al.,2015). The current state of the FFN is a consequence of the historical evolution of forests, which during the last century were limited and subject to economic pressure; anthropologic factor playing a huge role.(Postolache et al., 2006)

The area of forests covered varied from 30% (about two centuries ago) to 6% (in 1918), going from time to time to a slow recovery.(Mitchell et al.,2015) According to the statistics, the "Moldsilva" agency manages 337,7 thousand ha, of which 303,2 thousand ha (89,8%) represent forest-covered land. The annual deviations in terms of total area and forest-covered land are insignificant due to changes in the delimitation of public property, the periodic change of the mapping bases, as well as the particularities and conditions for the exercise of forest management in some years. (Moldsilva Agency 2020)

Most of the forest land is located in the central part (called Codrii). The southern part has the lowest percentage of afforestation. The current state of health of forests reflects a high pressure from unsustainable practices of illegal logging, as well as from biotic factors (pests, diseases) and abiotic factors (drought, pollution). The frequency of droughts has increased in recent decades and has significantly affected forest ecosystems, especially in the central and southern regions of the country. (Mitchell et al.,2015))

According to the national forest monitoring system and the results of the silo monitoring carried out by Moldsilva, forest ecosystems are heavily affected by defoliants, including exotic or invasive species. FFN pest-affected areas varied between 4,6. (2009) and 31 % (2003) of the surface area of the FFN, although up to 26,4 % of the affected areas of the FFN have been subjected to chemical or integrated treatment annually. (Mitchell et al.,2015)

The forest fund managed by the "Moldsilva" Agency, due to its variety of land and the need for various works, is divided into several land-use categories. In the framework of forest-development works and the completion of the plot descriptions, the electronic processing of which allows the identification of forest structure- the use of forest land falls into 25 categories of use. According to those data and current land records it is found that the total forest area managed by the "Moldsilva" is given in two distinct categories: (Moldsilva Agency 2020)

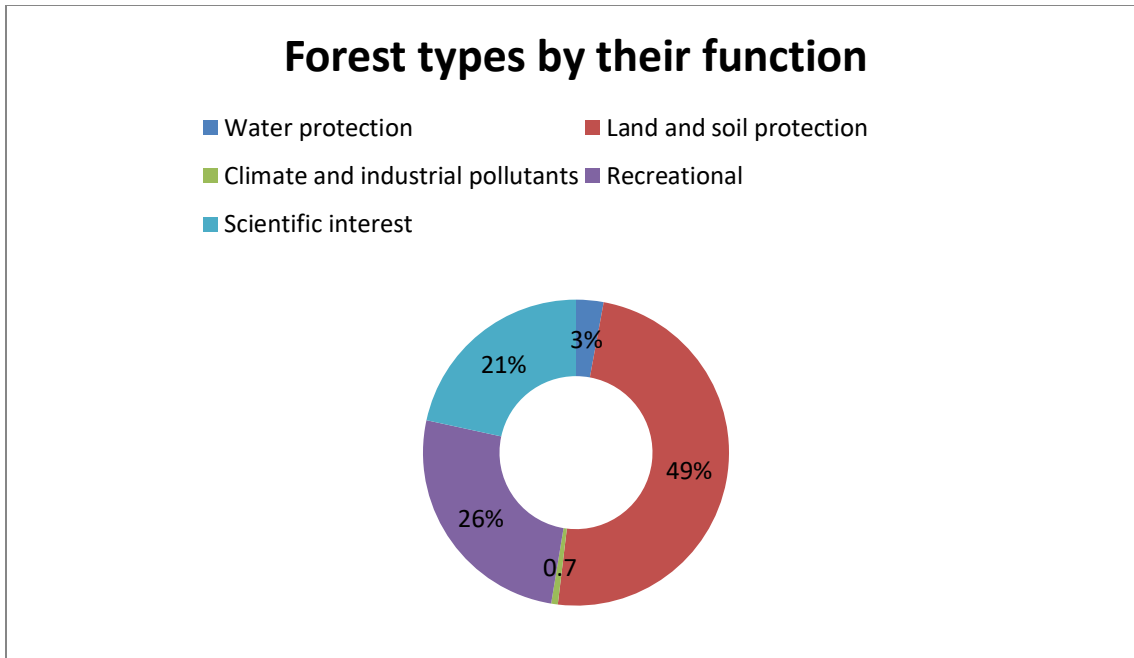
- ❖ Forest lands 325903,2 ha (96,5%) of which:
  - Lands covered by matured forests 303208,1 ha (89,8%);
  - Lands covered by uneven aged stands 7794,1 ha (2,3%)
  - Forestry nurseries 1179,6 (0,4%);
  - Forest fire protection breaches 847,8 ha (0,2%);
  
- ❖ Lands serving production and administration needs 11806,1 ha (3,5%) of which
  - Agricultural lands 4547,7 ha (1,3%)
  - Waters 1474,2 ha (0,4%)
  - Swamps 434,0 ha (0,1%)
  - Constructions 365,6 ha (0,1%)
  - Roads 778,8 ha (0,2%)
  - Other lands 4205,8 ha (1,2%)

The forest code establishes that forests have exclusive functions of protection and then production (which are determined according to their conditions). Five functional forest sub-groups are distinguished:

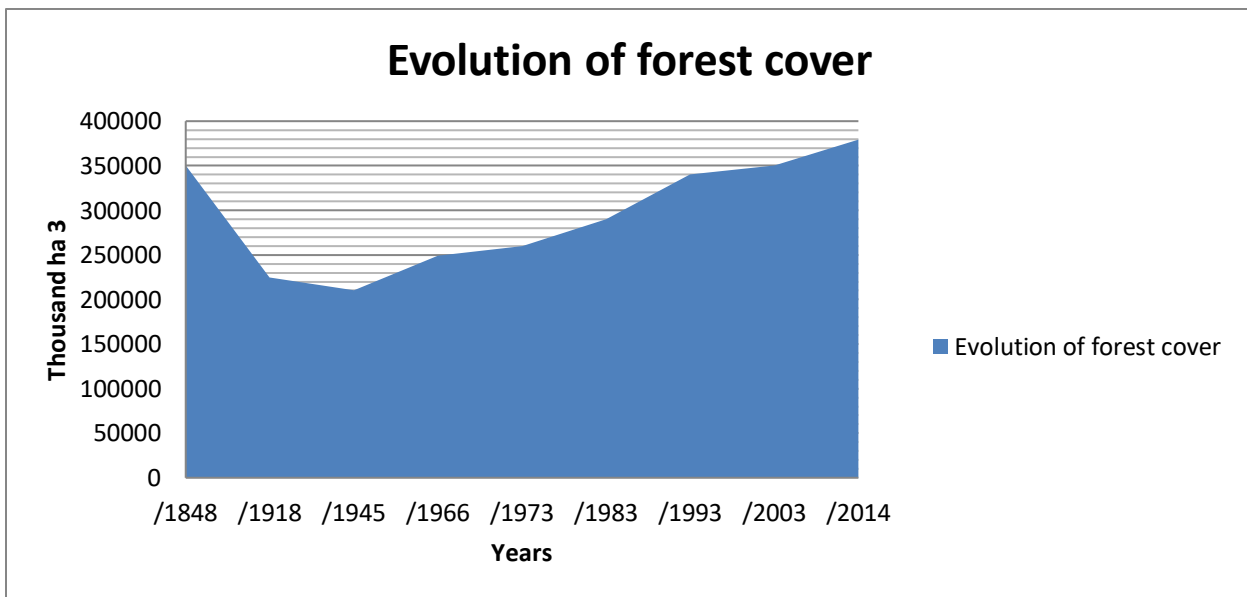
<b>Forest sub-groups</b>	<b>Area, ha</b>	<b>Percentage,%</b>
Water protection	8751,4	2,9
Land and soil protection	147550	49,0
Climate and industrial pollutants	2135,9	0,7
Recreational	77822,8	25,8
Scientific interest	64952,5	21,6

*Table 1. Area and percentage of forest types*

*Source: (Moldsilva Agency 2020)*



*Figure 1. Percentage of forest types by their function*  
*Source: (Moldsilva Agency 2020)*



*Figure 2. Evolution of forest cover in Moldova from 1848-2014*  
*Source: (Mitchell et al., 2015)*

### 4.3 Species composition

Human intervention to make excessive use of steppe regions for the development of the agricultural sector, measures to channel local river, draining of swampy lands, deforestation of forests and incorrect application of silvotechnical activities – all of this has led to a drastic reduction in biological diversity ( Mitchell et al., 2015). Many populations are also located at the extremities of the natural areas of the species, which increases vulnerability to climate change and the anthropogenic factor.

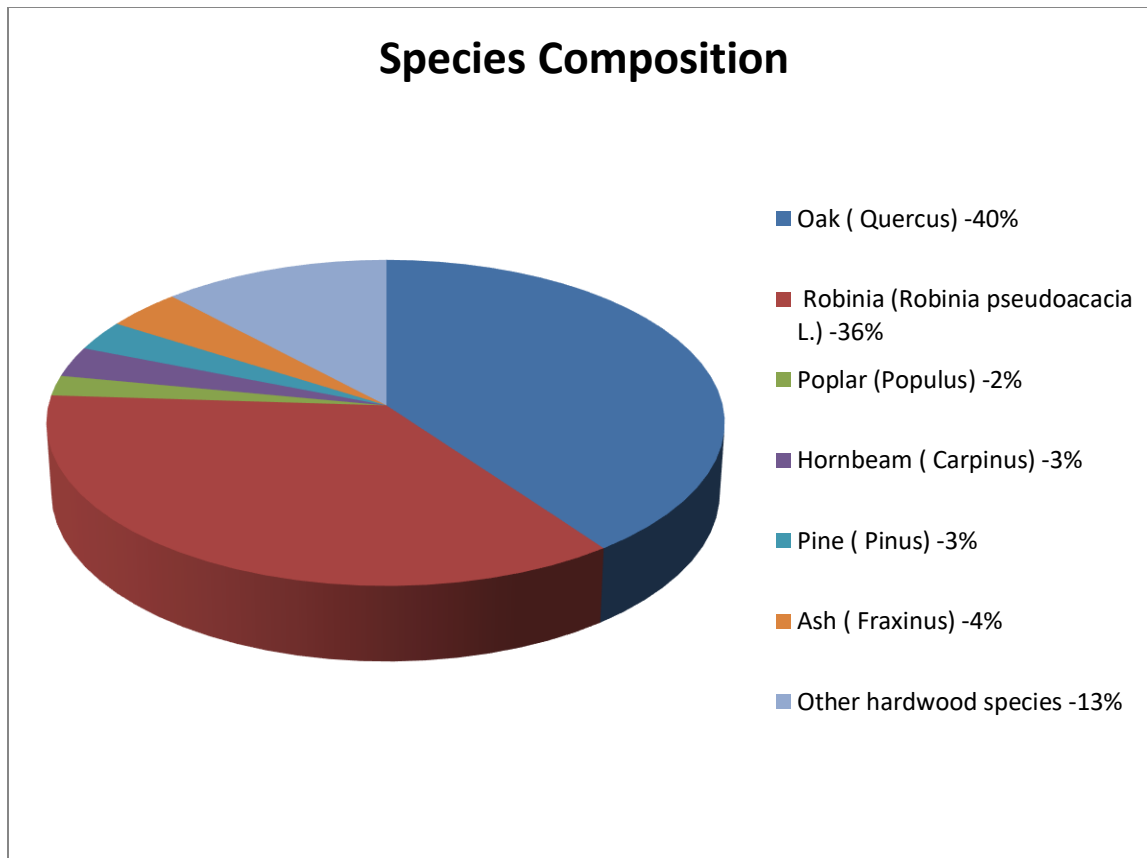
The tree floor of the forest fund managed by the "Moldsilva" Agency consists of a fairly wide variety of tree species. More than 65 tree species have been identified and described as part of the forest planning works: Pedunculate oak ( *Quercus robur*), Sessile oak ( *Quercus Petraea*), Pubescent oak ( *Quercus pubescens*), Grayish oak ( *Quercus pedunculiflora*), Red oak ( *Quercus rubra*), European beech ( *Fagus sylvatica*), White poplar ( *Populus alba*), Black poplar ( *Populus nigra*), Aspen ( *Populus tremula*), White willow ( *Salix alba*), Brittle willow ( *Salix fragilis*), Goat willow ( *Salix caprea*), Black locust ( *Robinia pseudoacacia*), European ash ( *Fraxinus excelsior*), American ash ( *Fraxinus americana*), *Fraxinus pallisae*, South european flowering ash ( *Fraxinus ornus*), Large-leaved lime ( *Tilia platyphyllos*), European white lime( *Tilia tomentosa*), Small leaved lime ( *Tilia cordata*), European hornbeam ( *Carpinus betulus*), Norway maple ( *Acer platanoides*), Sycamore maple ( *Acer pseudoplatanus*), Boxelder maple ( *Acer negundo*), Field maple ( *Acer campestre*), Tatar maple ( *Acer tataricum*), Wild cherry ( *Prunus avium*), Common walnut ( *Juglans regia*), American black walnut ( *Juglans nigra*), Field elm ( *Ulmus minor*), Scots elm ( *Ulmus glabra*), European white elm ( *Ulmus laevis*), Wild olive ( *Elaeagnus angustifolia*), Honey locust ( *Gleditsia triacanthos*), European white birch ( *Betula pendula*), White mulberry ( *Morus alba*), Black mulberry ( *Morus nigra*), Prunus mahaleb, Wild apple ( *Malus sylvestris*), European plum ( *Prunus domestica*), Cherry plum ( *Prunus cerasifera*), Wild cherry ( *Cerasus avium*), European wild pear ( *Prunus pyrastrer*), Sorb tree ( *Sorbus domestica*), Wild service tree ( *Sorbus torminalis*), Grey alder ( *Alnus incana*), Black alder ( *Alnus glutinosa*), Scots pine ( *Pinus sylvestris*), Black pine ( *Pinus nigra*), Norway spruce ( *Picea abies*), Oriental thuja ( *Thuja orientalis*), White pine ( *Pinus strobus*), European larch ( *Larix decidua*), Silver fir ( *Abies alba*), Douglas fir ( *Pseudotsuga menziesii*) and other species. (Moldsilva Agency, 2020)

The main edificator tree species from the forests of the northern part of the country are the Pedunculate oak ( *Quercus robur*) and the Wild cherry ( *Cerasus avium*). In the forests that are located in the centre of the country the main edificator species are the European beech ( *Fagus sylvatica*), Sessile oak ( *Quercus petraea*) and the Pedunculate oak ( *Quercus robur*). The forests from the southern part of the country have such edificator species as Pubescent oak ( *Quercus pubescens*) and Pedunculate oak ( *Quercus petraea*). In the basin of the river Prut and Nistru there can be found such edificator species such as the White poplar ( *Populus alba*) and White willow ( *Salix alba*). (Postolache et al.,2006)

The conclusion is that the forests of Moldova are dominated by deciduous species. Coniferous species are not native and account for only 2,2% of FFN. The *Quercus* species are considered the most important and valuable species. Of their total surface area - about 27 % are derived from seed and 73 % from shoots. This share also influences the productivity of the oaks, of which around 43 % are higher productivity and 57 % lower productivity.(Mitchell et al., 2015)

Abnormal and arid climatic conditions in recent years have had a negative effect on forest-pathological and plant health. The analysis of climatic conditions in recent years shows that the droughts are large and intensive. Thus, during the period 2010-2019, droughts were recorded in the country's territory in the years 2011, 2012, 2015, 2019 ( Taranu et al.,2021). The droughts of those years were classified as the strongest in intensity, by the affected territory and the damage caused. These droughts have led to changes in the hydrological soil regime, reduced the level of groundwater, thus worsening the conditions for growth and development of the main species of trees and bushes. As a result of these droughts there has been a sudden weakening of forest ecosystems, a reduction in the biological resistance of trees to the action of negative factors, the deterioration of stands, the intensification of large-area drying processes and the creation of conditions for the mass spread of phytopathic and xylophagus pests.

According to the results of detailed forest-pathological research, the area of the outbreaks of defoliating pests was of 83,81 thousand ha in Autumn 2019. Compared to the end of 2018 (101,3 ha), there is a 17,2% decrease in the area of the outbreaks of defoliating pests. The area requiring protection measures has also been considerably reduced from 54,8 thousand ha to 16,21 thousand ha (or 70,4%). (Moldsilva Agency, 2020)



*Figure 3. Species composition in Moldova*

*Source: Source: (Mitchell et al., 2015)*

#### 4.4 Timber

The total volume of standing timber is 46 million m<sup>3</sup> or 124 m<sup>3</sup>/ha. The average age of forests is about 40 years. The distribution of age classes is different, with a tendency toward younger age as a result of management/exploitation practices and the fact that more than 60% of the stands are of vegetative origin ( Mitchell et al., 2015). The total annual increase is 1252000 m<sup>3</sup>. (or 3,3 m<sup>3</sup> /ha), and the annual growth of forest vegetation outside the FFN is estimated at 110 000 m<sup>3</sup>. The annual volume authorized for harvesting in the forests managed by Moldsilva is around 40% of annual growth whereas the European average in 2010 was 58%. ( Moldsilva Agency, 2020)

Until 2009 the cutting activities were carried out exclusively by the forestry companies subordinated to the Moldsilva Agency. Since 2010, part of the volume authorized for harvesting has been exploited by public tenders organized by Moldsilva. In 2010, a volume of 112 000 m<sup>3</sup> was auctioned to private companies in 2011 – 101 100 m<sup>3</sup>, and in 2012 this volume was reduced



to 47 000 m<sup>3</sup>. (Moldsilva Agency, 2020) Most of the bidding lots were black locusts plantations, a species mainly used as firewood. The rest of the lots were operated by Moldsilva through its own companies, which employ the local population (including the seasonal staff of the forestry companies) for various forestry works. The prices of wood (working, fire) are set centrally by Moldsilva, and the list of prices for 1m<sup>3</sup> depending on species, quality and assortment is transmitted to the forestry companies, which are not too flexible to divert from these prices. However, the forestry companies are responsible for their own costs which determine their profit on sales. In 2013 the average price for firewood was 427 MDL/m<sup>3</sup> (\$27) (Mitchell et al., 2015). The timber is transferred between or within forest entities, in which case prices do not always correspond to market prices.

Between 2006 and 2010 the average proportion of working wood was 10,3% of the total volume of wood harvested, the rest being firewood. The working wood is processed mainly by the forestry companies in Moldsilva. Between 2006 and 2010 Moldsilva processed about 28 000 m<sup>3</sup> annually, or 7 % of the total volume of timber harvested, the rest is processed by private companies outside Moldsilva Agency. The annual processing capacity in Moldsilva is around 100 000 m<sup>3</sup> and is much untapped due to the low supply of wood (Mitchell et al., 2015). The processing technology and equipment are obsolete, resulting in reduced productivity, low recovery capacity and a lack of competitiveness.

A survey found that most wood is used as an energy source by the local population. Its annual consumption was estimated at 1 039 252 m<sup>3</sup>, or 74% of all domestic woody and non-woody biomass. Around 81% of respondents used wood as a primary energy source, mainly for heating, and 17% used wood for food preparation. According to official statistics, the contribution of the forestry sector to the energy sector balance is small (3,3% of total consumption of energetic resources and 12,3% of domestic energy consumption), while the results of the study show that the population is using much more wood resources. ( Mitchell et al.,2015)

Region	Number of households	Fire wood	Working wood	Non-woody sources	Total usage
North	345 747	200,533	10,372	44,947	255,853
Centre	533 207	506,547	15,996	154,630	677,173
South	202 544	332,172	14,178	123,552	469,902
<b>Total</b>	<b>1 081 498</b>	<b>1,039,252</b>	<b>40,547</b>	<b>323,129</b>	<b>1,402,928</b>
<b>% from total usage</b>		<b>74,1%</b>	<b>2,9%</b>	<b>23,0%</b>	<b>100,0%</b>

Table 2. Estimated annual energy biomass consumption

Source: (Mitchell et al., 2015)

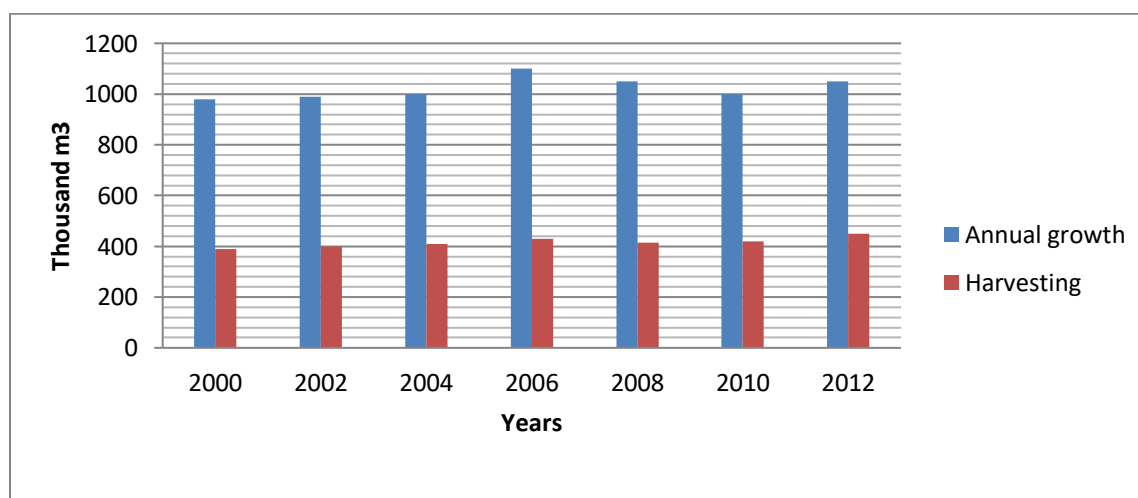


Figure 4. Annual growth and volume of cut

Source: (Mitchell et al., 2015)

## 4.5 Illegal harvesting

The Republic of Moldova participated in the FLEG ( Forest Law Enforcement and Governance) program in 2005 at St. Petersburg, at which for the first time the issue of strengthening the governance and enforcement of forest law in the countries of the region was raised. Together with 43 other countries, the Republic of Moldova signed the Declaration of this conference, which provided for the elaboration of a national action plan to combat illegal activities in the forestry sector. According to the study on illegal harvesting led by ENPI (European Neighbourhood Policy East Countries) FLEG, officially reported illegal logging volumes at low levels, although it revealed large proportions in non-Moldsilva forests (Mitchell et al.,2015). However, according to the estimate of annual wood consumption, about 1,039 million m<sup>3</sup> is fire wood only, which is about 3 times more than official figures on fire wood production. The total annual energy consumption of wood is estimated at 1,079 million m<sup>3</sup>, which represents 80% of the estimated annual growth in forest-growing areas (Mitchell et al.,2015). Although the discrepancy between the estimated consumption and the volumes of the official harvest may be due to a whole range of factors, this large difference shows the existence of large volumes of illegally harvested timber.

The most common types of illegal logging are: The undocumented harvesting of timber for energy or other purposes on land managed by APL (Local Public Authorities), harvesting timber for commercial purposes from forests and other forest vegetation land regardless of the type of property; manipulating timber quantities, including in the inventory process directly in the field, by not including these volumes in the legal documentation and ultimately creating corruption schemes and bribing staff involved in such activities (Galupa et al.,2011). It is not the gain in money, but rather the rise in wealth and the reduction of poverty that motivate illegal harvesting, especially in households that do not have the financial means to procure legal timber for heating and preparing food ( Galupa et al., 2011). In recent years, a number of actions have been taken to reduce the illegal activities of the forestry sector. Joint plans have been developed and implemented by the forestry authorities to ensure public security and environmental protection in the fight against illegal harvesting. But all this has proved to be insufficient. ( Galupa et al., 2011)

The current level of timber harvesting (legal plus illegal) in forests is unsustainable and if it continues in the same way, it will not only reduce the forest's capacity to supply timber

and firewood, but also over time, and to reduce biodiversity and increase deforestation/degraded forests which will lead to continued land degradation and erosion forests which will lead to continued land degradation and erosion.

<b>Owner</b>	<b>Total surface, thousand ha</b>	<b>Surface Subject to inspection, thousand ha</b>	<b>Illegal harvesting (m<sup>3</sup>) In 2010</b>	<b>Illegal harvesting (m<sup>3</sup>) In 2011</b>
Moldsilva Agency	336,3	302,4	3,869	2,562
APL	7	72,8	16,410	12,537
Total/media	411,6	375,2	20,279	15,099

*Table 3. Illegal harvesting in Moldova for the years 2010-2011*

*Source: (Galupa et al., 2011)*

#### **4.6 Degradation of land**

According to the general cadastre, the area of degraded agricultural land is 858 564 ha, or 46,7% of the total area of agricultural land According to other studies, the total amount of eroded land per country is 877 644 ha, of which 504 777 ha are poorly eroded, 259 332 ha are medium eroded and 114 165 ha heavily eroded (Moldsilva Agency, 2020). Soil degradation has become more intense in recent years years due to inadequate agricultural practices or/ and poor water management, as well as degradation of protective forest curtains. In the past 35 years, the area of degraded agricultural land has increased by 264 400 ha, or 10,4% of all agricultural land About 26 million tons of fertile soils are lost annually due to erosion. Direct and indirect annual losses due to erosion are estimated at 2,432 billion MDL (2, 942 billion CZK). (Moldsilva Agency, 2020)

The government recently approved the national Plan for the expansion of forest-growing areas for the years 2014-2018. Based on Moldosilva's study on the receptiveness of local public administrations to the afforestation initiative, the program foresees afforestation of 13 050 ha (10400 ha of degraded land, 1 650 ha of forest protective belts for water protection and 1 000 ha of forest shelterbelts for field protection). (Mitchell et al.,2015)

Forest curtains in the Republic of Moldova have an older tradition. Since 1947, they have been designed to protect agricultural land, water basins, transport routes and to reduce soil erosion. The total surface area of forest curtains is 30 300 ha. The main species are the Black locust ( *Robinia pseudoacacia*) (36%) and the Common walnut. (38%) but 12 other autochthonous species are present as well as 8 alien species. Centralized data on the current state of the forest curtains do not exist, although many of them are found to be affected by illegal harvesting, uncontrolled grazing, waste pollution or other destructive factors.(Mitchell et al.,2015)

The role of forest curtains in mitigating the effects of wind and water on soil erosion, as well as their positive contribution to increasing agricultural land productivity, their rehabilitation and the creation of new forest protection curtains, can be seen as an important priority for the forestry sector.

#### **4.7 National Forest inventory**

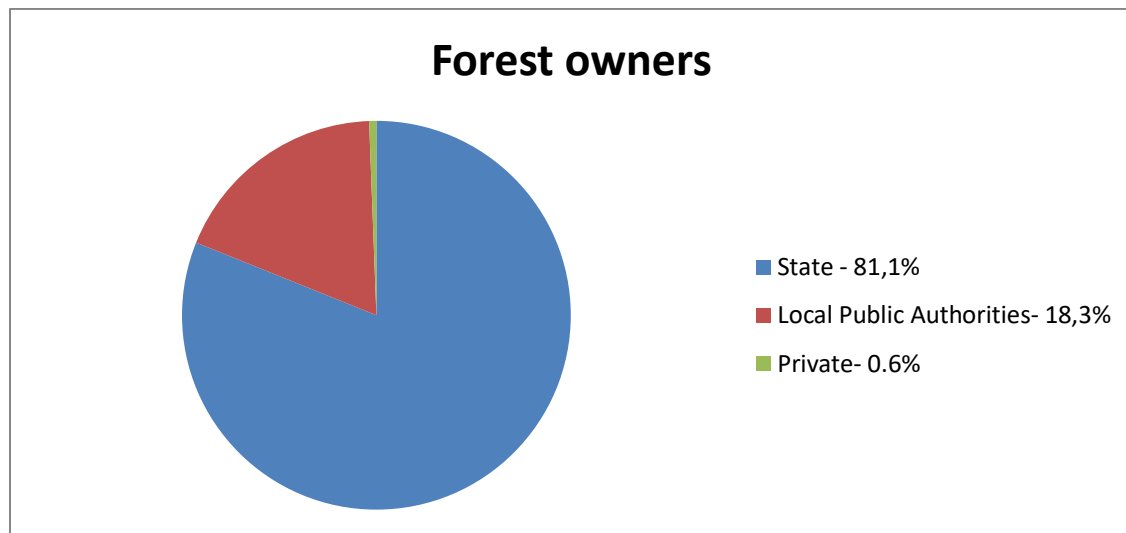
In Republic of Moldova there doesn't exist a national forest inventory. The record is based on: PAS ( Forest Management Plans) , which provides data on national forest resources and services of the Agency for Land Relations and Cadastre. Besides, not all forests are managed properly (Mitchell et al.,2015). Moreover, the purpose of the data collection in the field does not correspond exactly to the reporting requirements at international level.

A combination of a national forest inventory with strict implementation of the existing land records legislation would help forest sector of the Republic of Moldova to form a clearer view of their resources and status, facilitate the reporting process at national level in accordance with international standards. Such a forest inventory can provide credible information on deforestation, illegal logging, state of health and forest management of the Republic of Moldova.

## 4.8 Forest owners

According to data from the Register of real Estate (State Enterprise "Cadastru"), 81,1% of FFN is state-owned, 18,3% is owned by local public authorities and private property is only 0,6%. Moldsilva manages 82,9% of FFN. Other state institutions (central authority in water resources management, etc.) manage up to 3,8% of the FFN. (Mitchell et al.,2015)

The national institutions and organizations involved in the forestry sector are the Ministry of Environment, State ecological Inspectorate (subordinated to the Ministry of Environment), Moldsilva Agency and its subordinate entities, APL( Local Public Authorities) and private owners. (Forest code of Republic of Moldova, 2011)



*Figure 5. Forest owners in Moldova*

*Source: (Mitchell et al., 2015)*

### 4.8.1 Moldsilva Agency

The Moldsilva agency, subordinated to the Government, is the central public authority with the primary responsibility to implement the policy of the state in the field of forestry and game management. It is also responsible for drafting the regulatory framework in forestry and is directly financed by the government, independent from the Ministry of Environment. Moldsilva performs its functions through 25 subordinated entities – 16 forestry

districts, 4 forestry-game districts, 4 natural reservations and the Institute of Research and Forestry - ICAS. (Forest code of the Republic of Moldova, 2011)

The Moldsilva agency is the dominant employer in the sector. The analysis of employment shows a decreasing trend: 5619 employees in 2008 compared to 4100 employees in 2011. One important category is seasonal workers, the number of whom is estimated at 10 000 per year, although they are employed for relatively short periods of time. Employment takes place in rural areas and plays an important role in strengthening local communities by providing income opportunities. (Mitchell et al., 2015) Official data underestimate the total occupation, referring only to Moldsilva and ignores those trained in the barter system of providing services in exchange for firewood, as well as those employed in the unofficial economy (illegal harvesting). Employees are mostly men, especially where there is the need of operating with equipment.

<b>Year</b>	<b>Foresters</b>	<b>Engineers</b>	<b>Permanent Workers</b>	<b>Seasonal Workers</b>	<b>Total employed</b>
2013	1032	1245	590	1214	4082
2012	1031	1915	641	573	4160
2011	1049	1601	607	932	4189

*Table 4. Number of workers in Moldsilva agency for 2011,2012,2013*

*Source: (Mitchell et al., 2015)*

Moldsilva dominates the forest sector. It is the largest forest owner, the dominant supplier of forest fire and work wood, the main employer and beneficiary of the services contracted in the forest sector.

The "Moldsilva" agency ensures and exercises the protection of the forest fund it administers against illegal logging, theft, destruction, degradation, grazing, poaching and other damaging acts, as well as toward those who do not comply with fire prevention and fire-fighting rules. (Forest code of the Republic of Moldova 2011)

The functioning of the institution takes place on the basis of: Regulation on the organization and functioning of the Moldsilva Agency, its structure and cut-off staff, approved by the Government of the Republic of Moldova Decision No 150/09 of 02.03.2010

#### Tasks of the agency “Moldsilva”

- Ensures the integrity of managed forest and game funds
- Establishes the main directions of development of the forestry, organizes the exercise of control over the works financed from the state budget;
- Organize the protection of managed forests against illegal harvesting, theft, destruction, fire, illicit grazing and other damaging actions, provide the forest guard personnel free of charge with established model service equipment, weapons, ammunition;

#### Obligations of the agency “Moldsilva”

- Exercise control over compliance with the legislation in force in respect of its fields of activity; submit proposals for their suspension or cancellation in the event of deviations from the rules and standards in force;
- Establish, in concordance with other central and local public authorities ways to approve and regulatory documents in its fields of activity;
- Organize auctions and competitions for the exploitation of forest products and services, to achieve the objectives of the public-private partnership, to keep track of all tenders conducted in its fields of activity, and to detect infringements admitted to them
- To set up working groups, technical committees and boards within the Agency in its fields of activity; to set up inter-ministerial working groups with the agreement of the Government; to convene inter-sectoral councils on matters within its competence; (Forest code of the Republic of Moldova 2011)

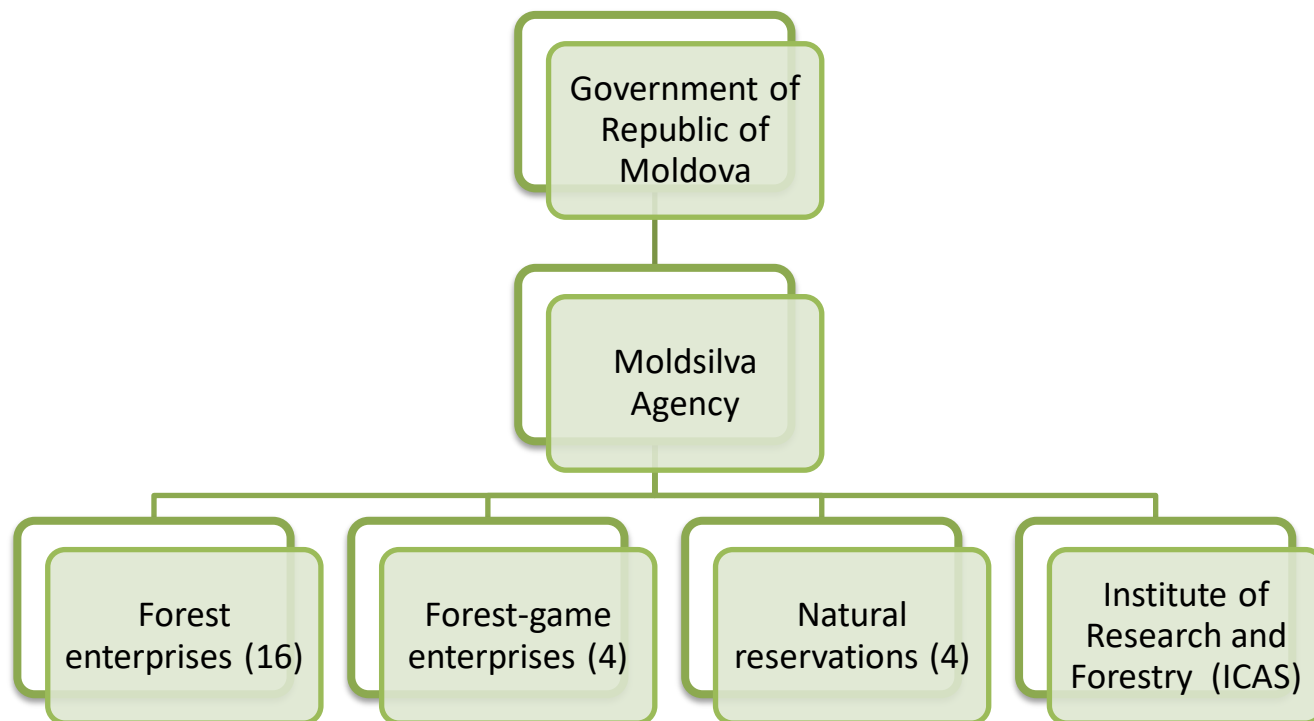


## 4.9 Legislation and Institutional Framework

The main legislative document in the field is the Forestry Code (adopted in 1996 with several obsolete and amendments along the way). The forest or forest-related legal framework is sometimes characterized by inconsistencies and overlaps in different legal acts. This adds a degree of complexity and creates obstacles to the implementation or even understanding of the regulatory and institutional framework in this area.

The Forest Code has been subject to a number of modifications and amendments, including in relation to international practices for sustainable forest management, the contribution of forests to climate change mitigation, the role of forests in providing ecological services, as well as in relation to the plans of the Republic of Moldova to join the EU. The main policy document in the field, approved by the Parliament in 2001, is the "Strategy for Sustainable Development of the Moldovan Forest sector". The forest-based sector actively participates in the implementation of the national Strategy and Action Plan on the Conservation of Biological diversity in the Republic of Moldova from 2001 as well. (Mitchell et al., 2015)

The national institutions and organizations involved in the forestry sector are the Ministry of Environment, the State organic Inspectorate (subordinate to the Ministry of Environment), the Moldsilva Agency and its subordinate entities, APL and the private forest owners, as well as other institutions holding smaller vegetation cover, As well as other institutions holding smaller forest-growing areas (Ministry of Transport and infrastructure of roads, Monasteries, etc.).(Forest code of the Republic of Moldova, 2011)



*Figure 6. Organizational structure of Moldsilva agency*

*Source: (Mitchell et al., 2015)*

The national forestry sector worked in isolation throughout its history and decisions were almost always taken without taking into account the benefit of external participation, which deepened the isolation and underestimation of the forest sector (Mitchell et al., 2015).

The legal framework must uphold ecological principles to ensure the genetic stability of forest ecosystems and the sustainable development of forest resources. Furthermore, the legal framework must promote the institutional reforms needed in terms of separation of economic and policy and regulatory functions, the development of the local forest sector, private sector participation and accordance of the legal framework with EU law.

## **5.0 Forest fire protection in Republic of Moldova**

The determination of prevention and extinguishing of fires in forests is made based on “Fire safety regulation;” from the Forest Code approved by the Government decision nr.740 17/06/2003. The Regulation on fire safety, hereinafter referred to as the Regulation, shall be drawn up in accordance with the provisions of Article 57(2) of the Forestry Code and other relevant legislation and shall lay down the manner in which forest fires are to be prevented and extinguished.(Forest code of the Republic of Moldova, 2011)

The tasks of the central forestry authority, local public administration and other forest-based land managers for the purpose of preventing and extinguishing fires in forests and other forest-growing fields are as follow:

- The development and implementation of fire-fighting prevention in forests and forest vegetation as well as the ones not included in the National Forest Fund, training of organizations and institutions for fire protection during a period of fire hazard;
- Annual approval of forest fire-fighting operational plans;
- Determine how to mobilize the population and the special fire-fighting equipment, provision of the persons trained in such work with means of transport, food and medical care;
- The organization of regular media coverage of matters relating to forest conservation and respect for fire safety through the written press and audiovisual media;
- Ensure coordination of all forest fire-fighting measures;

(Forest code of the Republic of Moldova, 2011)

The responsibility for the breach of forest fire protection requirements lies with the persons responsible for the management of the work in the forest, or persons responsible for the pursuit of the various educational and recreational activities in forests, natural and juridical persons with forest use rights. State control over the fulfillment of the provisions of this regulation shall be exercised by the central environmental authority, the bodies of state surveillance of fire-fighting measures jointly with the local public administration authorities. The departmental control of compliance with fire protection rules in forests and forest vegetation outside the national forest fund is carried out by the ministries, departments, enterprises,

organizations and institutions, which own these land. (Forest code of the Republic of Moldova, 2011)

### **General requirements for physical and juridical person**

During the period of fire hazard (from the melting of snow in the forest to the steady winter rain season or the falling of the snow layer), it is prohibited:

- Ignition of pyres in vicinity or in the forest areas;
- The disposal of burning matches, cigarette mugs and burning ashes;
- Disposal of materials soaked in grease, diesel, petrol, etc. at places other than those intended for these purposes;
- The fuel supply of motor vehicles with the engine running or with engine fueling system failures, as well as smoking or the use of open fire near them;

Enterprises, organizations, institutions and other natural and juridical persons, which carry out forestry operations, are obliged, regardless of the methods and time of cutting, to carry out at the same time the cleaning of the woody debris of the territory on which these activities were carried. The methods of cleaning are indicated by the forest enterprises. When performing all kinds of forestry cuts, methods for cleaning the wood debris without the usage of fire are generally applied. In exceptional cases, the burning of wood debris may be carried out only until the beginning of the fire hazard period or the autumn, after the end of the fire hazard period. In line with the complete burning of the wood debris, it will be ensured that the seeds from the area are kept and that the remaining trees are intact. Burning wood debris by a fire with a continuous flame is prohibited. (Forest code of the Republic of Moldova, 2011)

Yearly, according to the Agency “Moldsilva”, the fire prevention and fire-fighting activity is an integral part of the economic or social-cultural activity carried out by the Agency’s sub-units. It carries out: educational activities on forest fire prevention measures; development of forest fire prevention measures plan.

**Instructive and educational measures** on forest fire prevention measures by forest enterprises :

- Raising public awareness of the destructive effects of forest fire;
- Raising individual awareness of each citizen's patriotic responsibility for saving and preserving the forest heritage in cooperation with the forest administration;
- Compliance of the entire population with forest fire protection rules, engagement in the observation and notification of authorities in case of fire outbreak;
- Promoting relations with all local administrative organizations with a view to achieving effective forest fire prevention and fire-fighting measures;
- The organization of specific educational and training events for the population that are living close to forest-related areas;
- The forest enterprises will review and delimit the forest's permissible places for, smoking and car parking and tourism interest;
- Signs with appropriate text on fire prevention and fire-fighting will be placed on the entrances of the forest and tourist routes;
- During droughts, patrols will be organized with the aim of prevention of fire outbreaks;
- Training on forest fire prevention measures with forest workers, drivers, those who collect medicinal fruits and plants, tourists and students on summer camps;

### **Prevention of forest fires**

Silvicultural means for preventing forest fires:

- Establishment of mixed stands with fire resistant species;
- Mineralization of protective barriers, especially during periods of drought;
- Forest hygiene measures through the removal of fallen, broken, dried trees;

Observational means:

- Regular (holiday)/permanent patrols (during periods of drought in the most exposed areas);
  - Installation of observatories where the most exposed areas can be monitored;
- (Scobioala, 2011)

## **5.1 Classification, characteristics, localization and extinguishing of forest fires in Republic of Moldova**

Forest fires in Moldova are classified on the same principles as in Romania and they are as follow:

- ❖ **Crown fires**
- ❖ **Litter fires**
- ❖ **Sub-surface**
- ❖ **Fires in areas with fallen trees**
- ❖ **Combined crown and litter fires**

(Scobioala,2011)

### ❖ **Characteristics of litter fires**

In the case of these fires, the fire burns through: the woody material trimmed and stored in the stacks, the trees cut down for trimming and the bark of the trees that are standing , on their lower part. Litter fires develop unevenly, they spread in jumps in different directions in relation to changes in the air currents and the moisture state of the materials encountered. The litter fire can be recognized from far distance by the white-gray smoke it produces.

During combustion, temperatures of 800 to 1200 °C develop in relation to the type of wood, its degree of humidity and the quantities of material subject to burning. Large amounts of oxygen are consumed in the burning area, leading at some point to the emergence of the phenomenon of high absorption of air from the unburned area and the formation of vortex which raises sparks, or pieces of wood burning and carrying them at long distances where falling causes new fire outbreaks. Litter fires can easily turn into coronary fires if the vegetation on the forest soil that burns touches the tree crown – especially in the coniferous forests.(Boas et al.,2013)

### ***Localization and extinguishing of the fire***

Littering fires are extinguished using mechanical and chemical processes. The procedures with mechanical processes are:

- beating the burned areas with large twig brooms, fascines, shovels;
- fire suppression with soil or sand;
- create obstacles to limit the spread of fire (felling trees and clearing a strip of varying width across the wood, digging ditches and making arches, using the equipment and human forces at its disposal);
- extinguishing the fire with water when there are alignments from which the specialized equipment can be used ;

The usage of chemical procedures- includes the spreading of solid or liquid chemicals in the fire area to clear fire by means of ground equipment ( pumps, delivery pipes) or special aircraft for the spreading of substances against chemical pests or chemical fertilizers.(Taranu et al., 2021)

The localization of litter fires shall be ensured by encircling the burned area with emergency personnel (professional and voluntary structures for emergency situations, forest workers, citizens) and by concentrating the main forces on the direction of the spread of the fire (direction of the wind). Forces concentrated in the localization and the extinguishing of the fire may be deployed frontal, when on the sidewalls and rear fire cannot develop due to local conditions or directions of propagation. (Boas et al, 2013)



*Figure 7. Propagation of fire in a single direction*

*Source: ( Boas et al.,2013)*

For the localization of the fire, makeshift twig brooms, shovels, raffles, etc. will be used complementing this action with the execution of mineralized protective belts, 1-2 m wide and digging to remove dead spots and woody debris.

The intervention forces may have the following missions:

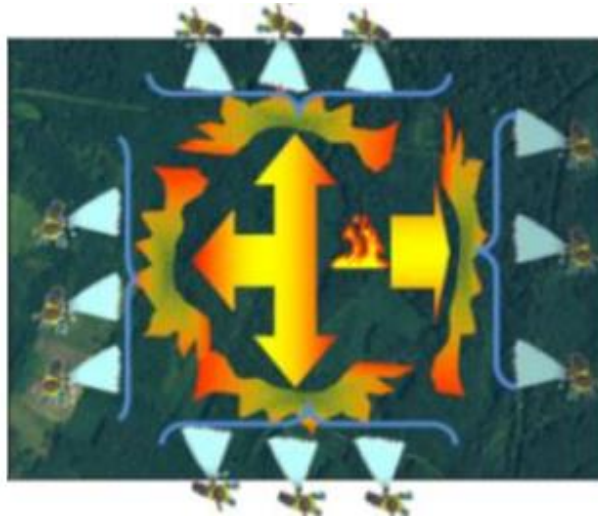
- to limit the spread of fire by cleaning the field in front of fire of all combustible materials;
- extinguishing the fire , using the available means;
- fire-isolating, by creating isolation strips;



*Figure 8. Propagation of fire in three directions*

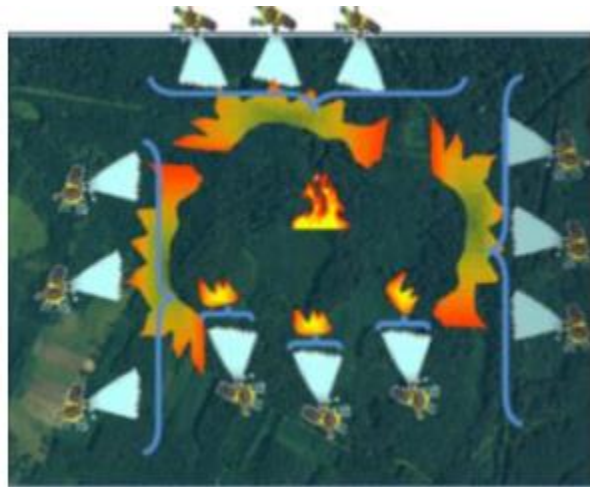
*Source: ( Boas et al.,2013)*





*Figure 9. Propagation of fire from all directions*

*Source: ( Boas et al.,2013)*



*Figure 10. The existence of several outbreaks of fires of different sizes*

*Source: ( Boas et al.,2013)*

#### ❖ **Characteristics of crown fires**

These fires occur mainly in the coniferous forests, and their development is greatly promoted by the resin contained in the branches and tree trunks as well as by the turpentine and the ether oils contained in the leaves. In case of crown fires in coniferous forests, the fires are propagated intensively through the burning cones which crack and are scattered by the air

therefore burning the crowns of trees. In many cases the fire is spread to the ground by burning material falling on the litter.

Depending on the burning rate and intensity of the combustion, crown fires are classified as follows:

- slow fires: burning speed up to 8 km/h;
- rapid fires: burning rate 8 – 25 km/h;
- violent fires: burning speed more than 25km/h;

### ***Localization and extinguishing of the fire***

For the localization and extinguishing of crown fires it is necessary to use techniques and tactics adapted to their rate of forward movement. As a rule, crown fires call for numerous and well-organized forces to be concentrated. Because of the high forward speed and in particular the direct effects of the fire (radiated heat, flames, sparks worn by wind, ignited materials, etc.), it cannot always be stopped to the immediate limit on which it is found, and must be faced with a natural or artificial obstacle, isolation strips created in advance (Boas et al., 2013).

The protective barrier shall be made perpendicular to the direction of the forward of the fire, at a distance calculated according to the forward speed, the type and height of the forest, the duration of protective barrier creation operations, the forces and technical means available. The superficial calculation of these data are made with the thought that the fire may affect the personnel who are creating the barriers, forcing them to leave the works.

Barriers are made by the felling of trees and the cleaning of the vegetation from land, by using mechanical, electrical and manual saws, axes, other machinery or the method of explosion (Mitchell et al.,2015). In the event that the crown fire is particularly strong and there is no certainty that it can be localized within the limits of a protective barrier, the technique known as “fire against fire” shall be used. This procedure is only used as a last resort for the use against forest fires. It shall not be used when there is a strong wind or when the forest is located on a rugged terrain (Boas et al., 2013). An effective technique to create conditions for the location of coronary fires is that of explosions. The explosion can be used for fitting mineralized belts and areas free of combustible materials for protection. The "fire against fire" intervention technique is defensive action and is adopted only when the lives of individuals are not directly or ultimately threatened to ensure the safety of their personnel.(Boas et al., 2013)

### ❖ **Characteristics of sub-surface fires**

These fires occur mainly in the old-growth forests, on which a thick layer of dry leaves, branches, woody residues that have rotten formed a layer of rot and peat over the years (Scobioala , 2011).

Sub-surface fires destroy the roots of the trees and under favorable conditions they can spread to the litter as well. Underground fires have an indication of their appearance outside, in particular, smoke coming out of various cracks, where oxygen is supplied from the atmosphere in the combustion area, have an irregular pattern of appearance, depending on the cracks in the dead layer and the obstacles encountered in the way (Boas, et al., 2013).

### ***Localization and extinguishing of the fire***

In order to extinguish sub-surface fires, the first step is to determine the path of the fire according to the external indicators (smoke and heat). Once the perimeter of the fire has been established, the location of the fire shall be circled with a 1-2 m wide protective barrier; carried out with the removal of the peat. The ditches thus created shall be filled with water, if possible, and the area of land on the non-fire side shall be sprayed with chemicals to increase the resistance to fire of vegetation. After it has been localized, the outbreaks of fire are covered by excavations and their extinguishment by spraying with water or covering with earth. (Boas, et al., 2013).

In the extinguishing operations, particular attention shall be paid to the verification of the fire site so as not to have hidden outbreaks which would then lead to the re-outbreak of the fire. The fire-fighting technique by beating the fires in the forward direction or by throwing the earth to suppress the fire is efficient but exhausting and requires numerous working forces, which must be changed periodically to ensure continuity of operations, because discontinuation of work results in resumption of the fire. (Boas, et al., 2013).

### ❖ **Characteristics of combined crown and litter fires**

Such fires occur as a result of the spread of litter fires at the tree crowns in areas where the thickets and bushes constitute a favorable medium for their spread.

In many cases, the fire has spread from litter to tree crown due to heat transmission by convection and radiation, which has produced the distillation of volatile products contained in resins, thus constituting an appropriate medium for the propagation of flames at a height, by the ignition of volatile gases released.(Scobioala, 2011)

This process takes place continuously in the case of large coniferous trees where the fire instantly ignites the crowns and give the appearance of a fire wave.

### ❖ **Characteristics of fires in areas with fallen trees**

These fires are rapidly developing due to the existence of, the dry bark of trees and the large amount of wood material on forest soil. The rate of propagation depends on the amount of wood, its nature, its moisture and weather conditions, and the topographic characteristics of the terrain. (Boas et al.,2013)

### ***Localization and extinguishing of the fire***

In the event of such fires, the focus is on location, especially when the disaster area borders with densely wooded areas. Isolation belts will be created for the location, cleaning the boundaries of the area of from any vegetation that would contribute to the spread of the fire. In the action of extinguishing the outbreaks, a careful check of each of the broken trunk and the closing of the hidden outbreaks will be carried out.

Localization and the extinguishing of the fire is greatly facilitated if there is a possibility of using motor-pumps, the special intervention vehicles from which the required number of pipes can be fitted, or ATV-type vehicles fitted with an extinguishing installations.

The fact that forested areas include localities with households spread over large areas, or social housing for forest workers (bedrooms, canteens, storerooms) or tourist targets which in the event of major fires may be threatened, calls for particular attention to be paid to ensuring

their protection. During air recognition, the number of these housings will be assessed based on the direction in their propagation of the fire the measures to protect them will be determined.

The existence of these objectives requires the use of additional forces that have to execute:

- the creation of barriers around them by felling down close trees;
- cleaning of the area of combustible materials;
- the creation of water reserves in their vicinity;
- evacuation of goods, people and livestock from the area;

### **Fire extinguishing substances**

In the case of forest fires, the following fire extinguishing substances shall be used:

- water
- firefighting foam
- chemical substances
- earth, sand
- explosive materials

Water – is most often used to put out forest fires in regards to the efficiency.

Depending on the topography of the terrain and the fire situation, water may be transported to the place of fire using fire fighting vehicles, tanks for the transport of various products, utility airplanes, buckets or improvised means. (Cornea, 2014))

Fire-extinguishing chemicals are divided into two groups:

- long-term fire retardants;
- short-term retardants;

Short-term fire retardants are composed of water and an additive which reduces the rate of evaporation of water to achieve a higher extinguishing effect. These additives also contribute to a better distribution of water on the surface of burned vegetation. They are also called thickeners, such as those made of silicon, and cover the leaves with a layer that reduces the rate of water evaporation. (Cornea, 2014)

The second group of chemical substances are long-term fire retardants. The long-term fire retardants consist of ‘delay salt’ (based on ammonium compounds or phosphates) and a color

dye which makes it easier to identify the areas where these substances have been used. The iron oxide, the dye used in the past, had the disadvantage of being disposed of by washing, for which it was replaced by compounds that were not degraded until a few weeks have passed. (Cornea, 2014)

### **Recognition of the fires**

Recognition teams equipped with means of communication shall be sent in several directions which will report on a permanent basis on the situation in the areas concerned and propose measures on the location and extinguishing of the fires.

The following shall be established on recognition:

- type of fire ( litter, crown, sub-surface etc.);
  - type of the forest ( coniferous, deciduous, mixed);
  - the speed of the propagation of fire as well as the direction of the wind;
  - the portions of the land that have the most dense tree stands, as well as the woody debris on the soil;
  - the presence of danger for various constructions inside the forest;
  - the possibilities of changing the direction of propagation of a fire in relation to the change of wind direction;
  - the existence of various obstacles to the spread of fire (water, roads, protective barriers, etc.);
  - fire-extinguishing tactics and techniques as well as the substances which will be used;
- (Boas et al.,2013)

### Forest fire protection equipment logistics

<i>№</i>	Name of the equipment	Unit of measure	Forest enterprise	Forest district	Technical sector	Forest range
1.	Truck 2,5 t	<b>Piece</b>	<b>1</b>	<b>1</b>	-	-
2.	Removable cisterns with a volume of 1500 l	<b>Piece</b>	<b>1</b>	-	-	-
3.	Transportable motor pumps 600-800 l	<b>Piece</b>	<b>1</b>	-	-	-
4.	Fire-fighting gloves	<b>Pairs</b>	<b>100</b>	-	-	-
5.	Tractor with plough	<b>Piece</b>	<b>1</b>	<b>1</b>	-	-
6.	Fire-extinguishers	<b>Piece</b>	<b>10</b>	<b>5</b>	-	-
7.	Chainsaws	<b>Piece</b>	<b>2</b>	<b>1</b>	-	<b>1</b>
8.	Spades	<b>Piece</b>	<b>20</b>	<b>15</b>	<b>10</b>	<b>5</b>
9.	Pickaxes	<b>Piece</b>	<b>10</b>	<b>5</b>	<b>5</b>	<b>5</b>
10.	Steel rakes	<b>Piece</b>	<b>10</b>	<b>5</b>	<b>5</b>	<b>5</b>
11.	Sprinklers	<b>Piece</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>
12.	Manual saws	<b>Piece</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>
13.	Water bottles 20 l	<b>Piece</b>	<b>10</b>	<b>10</b>	<b>5</b>	<b>5</b>
14.	Steel buckets	<b>Piece</b>	<b>10</b>	<b>10</b>	<b>5</b>	<b>5</b>
15.	Cups for water	<b>Piece</b>	<b>10</b>	<b>5</b>	<b>5</b>	<b>4</b>
16.	Water barrels with a volume of 200l	<b>Piece</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>

17.	First aid kits	Piece	3	2	1	1
18.	Respirators	Piece	According to the number of members of the fire brigade team			
19.	Safety goggles	Piece				
20.	Special uniform(pants, boots, gloves)	Piece				
21.	Axes	Piece	10	3	2	2

*Table 5. Forest fire protection equipment logistics in all forest-related enterprises*

*Source: (Scobioala, 2011)*



Categories	1990	1991	1992	1993	1994	1995	1996	1997
Right bank of river Nistru	120.10	20.10	22.00	1.50	33.50	1.40	0.00	0.00
Left bank of river Nistru (TRANSNISTRIA)	IE	IE	IE	IE	IE	0.53	11.20	3.40
Total	120.10	20.10	22.00	1.50	33.50	1.93	11.20	3.40
Categories	1998	1999	2000	2001	2002	2003	2004	2005
Right bank of river Nistru	9.70	0.00	0.00	41.60	12.50	10.50	42.00	5.50
Left bank of river Nistru (TRANSNISTRIA)	24.00	25.20	0.90	15.40	18.10	23.00	46.00	2.90
Total	33.70	25.20	0.90	57.00	30.60	33.50	88.00	8.40
Categories	2006	2007	2008	2009	2010	2011	2012	2013
Right bank of river Nistru	32.60	683.30	31.00	126.00	20.00	25.90	636.60	460.00
Left bank of river Nistru (TRANSNISTRIA)	58.20	108.00	24.00	8.20	26.90	36.90	35.80	7.10
Total	90.80	791.30	55.00	134.20	46.90	62.80	672.40	467.10
Categories	2014	2015	2016	2017	2018	2019	2020	2021
Right bank of river Nistru	9.50	338.20	119.00	173.00	79.00	169.68	402.0	N/A
Left bank of river Nistru (TRANSNISTRIA)	28.90	18.00	59.8	73.80	5.90	34.40	17.2	N/A
Total	38.40	356.20	178.8	246.80	84.90	204.08	419.2	N/A

Table 6. Forest areas covered by fires in Republic of Moldova between 1990 and 2020, ha

Source: (Taranu et al., 2021)

Years	North zone		Central zone		South zone		Total	
	Distance, km	Sum, thousand MDL	Distance, km	Sum, thousand MDL	Distance, km	Sum, thousand MDL	Distance, km	Sum, thousand MDL
<b>2012</b>	77,0	33,46	142,0	59,1	388,0	64,66	607,0	157,2
<b>2013</b>	92,0	44,72	226,0	109,0	309,0	58,64	627,0	212,3
<b>2014</b>	79,0	40,57	178,0	86,6	297,0	60,69	554,0	187,9
<b>2015</b>	57,0	17,19	179,0	77,8	301,0	53,55	537,0	148,6
<b>2016</b>	73,0	23,49	206,0	75,7	243,0	43,33	522,0	142,5
<b>Average</b>	75,6	31,89	186,20	81,64	307,60	56,17	569,40	169,70

Table 7. Creation of mineralized protective belts against fire in Rep. of Moldova in the years 2012-2016

Source: (Moldsilva Agency, 2017)

Years	North zone		Central zone		South zone		Total	
	Distance, km	Sum, thousand MDL	Distance, km	Sum, thousand MDL	Distance, km	Sum, thousand MDL	Distance, km	Sum, thousand MDL
<b>2012</b>	5,0	16,06	14,0	90,95	0,00	0,00	19,0	107,0
<b>2013</b>	12,0	53,54	29,0	121,41	3,0	5,26	41,0	180,2
<b>2014</b>	15,0	45,40	31,5	73,99	9,0	24,31	50,5	143,7
<b>2015</b>	6,0	23,45	27,3	33,78	4,0	11,31	34,3	68,5
<b>2016</b>	3,0	5,50	15,0	20,09	3,0	17,19	21,0	42,8
<b>Average</b>	8,2	28,79	23,36	68,04	3,80	11,61	33,16	108,45

Table 8. Construction of forest roads for fire-fighting purposes for years 2012-2016

Source: (Moldsilva Agency, 2017)

Years	North zone		Central zone		South zone		Total	
	Nr.of workers	Sum, thousand MDL	Nr.of workers	Sum, thousand MDL	Nr.of workers	Sum, thousand MDL	Nr.of workers	Sum, thousand MDL
<b>2012</b>	15,0	99,79	58,0	427,02	34,0	155,44	107,0	682,26
<b>2013</b>	12,0	60,08	34,0	346,45	17,0	231,86	63,0	638,40
<b>2014</b>	5,0	228,08	13,0	369,09	12,0	282,35	30,0	879,52
<b>2015</b>	0,0	284,35	0,0	372,9	0,0	85,52	0,0	742,75
<b>2016</b>	18,0	823,07	27,5	225,4	10,0	267,86	55,5	1316,36
<b>Average</b>	10,0	299,07	26,51	348,18	14,60	204,61	51,11	851,86

*Table 9. Temporary hiring of fire-watchmen for years 2012-2016*

*Source: (Moldsilva Agency, 2017)*

## **6.0 Practical part**

On 31<sup>st</sup> of March, I have visited 1 forest district and 3 forest ranges under its subordination in the Stefan-Voda district, in order to inspect the fire-fighting equipment and to talk to the foresters about the situation in general. The Stefan-Voda district was chosen because my father's village is there and also the district is quite far from the capital city, it is bordering Ukraine and unrecognized State of Transnistria, those are the reasons I have chosen to visit the forest ranges and the forest district because they might reflect more objectively the situation, also keeping in mind that Stefan-Voda is one of the poorest districts in Moldova.

The forest district and the ranges are part of the “Forest Enterprise Tighina”. The total territory of the forest fund managed by the enterprise is 23411,6 ha of which 19685,6 ha is covered by forest. (Moldsilva)

First location visited was the Forest District of Olanesti, at the arrival 1 forest engineer and 1 forester was present, at the beginning they were not very cooperative but in the end they have agreed to show the fire-fighting equipment, to travel to 3 forest ranges under the subordination of the forest district and to talk about the issues and the problems they were facing, but they have asked to remain anonymous.



*Photo 1. Forest district Olanesti*

*Source: (Lungu Daniel)*



*Photo 2. Emergency fire box in forest district of Olanesti*

*Source: (Daniel Lungu)*

The forest district Olanesti fire equipment was in dire condition and a lot of the equipment was missing according to the Table 5. *Forest fire protection equipment logistics in all forest-related enterprises*. The equipment that was available: 2,5 t truck ( it wasn't present at the moment of visit), some of the equipment was locked in a room that they didn't allow to take pictures of, 1 chainsaw ( 1 required), 1 fire extinguisher ( 1 required), 2 spades ( 15 required), 1 steel rake ( 5 required), 2 manual saws ( 2 required), 1 steel bucket ( 10 required), 1 first aid kit ( 2 required), 1 axe ( 3 required). The equipment they didn't have : no tractor with plough ( even though they have a person of contact from the Olanesti village that has one), no spades, no



pickaxes, no sprinklers, no 20l water bottles ( they had some 9l bottles though) , no 200l water barrels, no cups.

The second location visited was Forest range Nr.8, which has a total surface area of 266,8 ha.



Photo 3. Forest range Nr.8 entrance sign

Source: (Lungu Daniel)



*Photo 4. Forest range Nr.8*

*Source: (Lungu Daniel)*

Being a smaller administrative unit than a forest district, means that it has less logistic requirements according to the *Table 5*, nonetheless it still had problems with the equipment, so the equipment that was available was: 1 fire-extinguisher ( it wasn't required but it was privately owned by the forester working there), 1 chainsaw ( 1 required), 1 spade ( 5 spades required), 1 steel bucket ( 5 required), 1 200l water barrel ( 1 required), 1 axe ( 2 required). It didn't have any pickaxes, no steel rakes, no 20l water bottles ( they had some smaller water bottles inside the house), no first aid kits, and no cups.





*Photo 5. Emergency fire box from range Nr.8*

*Source: (Lungu Daniel)*





*Photo 6. Forest Range Nr.8 ; According to the forester might be the oldest Pedunculate Oak (Quercus robur) from the East of the Republic, ca. 200 years old*

*Source: (Lungu Daniel)*



Ironically while en-route to the third location, we have spotted some fire along the highway, it was fire intended for agricultural purposes, which is the number one cause in Republic of Moldova that triggers forest fires, these fires should be always supervised by fire-teams in order for the fire to not propagate in a lot of directions, and even though it was a windy day nobody was present at the place.



*Photo 7. Fire and smoke spotted along the highway in Stefan Voda district*

*Source: (Lungu Daniel)*

The third location that was visited was the Forest range Nr.3



*Photo 8. Forest range Nr.3 entrance sign*

*Source: (Lungu Daniel)*

Out of all the locations that have been visited the Forest range Nr.3 was in the worst conditions and it didn't seem that anyone was working there for some time, there was also some



garbage around the house, which most probably meant that the forester working there hasn't been there in a long time.



*Photos 9 and 10. Emergency fire box from Forest range Nr.3*

*Source: ( Lungu Daniel)*

As can be concluded from the photos, the only fire-fighting equipment in the emergency fire box was just a steel bucket and a small water bottle, unfortunately there were no keys for the house but judging from the windows and the attic ( where I have tried to climb) there wasn't any indication of any fire-fighting equipment, which is quite of a problem.





*Photos 11 and 12. Forest range Nr.3 house and ladder to the attic*

*Source: (Lungu Daniel)*



The fourth location that was visited was the Forest range Nr.2 which has a total surface of 557,4 ha.



*Photo 13. Forest range Nr.2 entrance sign*

*Source: (Lungu Daniel)*

The forest range Nr.2 fire-fighting equipment was more diverse than the previous one. They didn't allow to take pictures inside the house but from the equipment that they had was : 1 steel rake ( 5 required), 1 spade ( 5 required), 2 axes ( 2 required), 1 steel bucket ( 5 required), 1 fire-extinguisher . No chainsaws, no pickaxes, no sprinklers, no manual saws, no cups, no 200l water barrel, no 20l water bottles ( there were a couple of 6l water bottles) and no first aid kit.





*Photo 14. Emergency fire box from the Forest range Nr.2*

*Source: (Lungu Daniel)*

## 6.1 Subjective assessment of the situation

This visit raised more questions than it answered, as it can be judged by the pictures and the equipment available that in most of the forest ranges and forest districts- the reality doesn't correspond to the paperwork. I have asked at the end the forester and the engineer to talk about the reality of the situation with fires in forests and they gave a bit of interesting information. In case of a forest fire the first thing that the forester does is to announce by phone the director of the forest district, to announce the foresters of the nearby ranges and to assess the situation, in case the fire is too severe and cannot be stopped, the emergency service is called and asked for assistance, unfortunately in Stefan Voda district there are only 2 brigades of fire-fighters with 2 trucks. Last time they have called them was a couple of days before my visit, they said that 2 forest fires broke out, but all the fire-fighting cars were present at Palanca ( border zone with Ukraine ) dealing and helping the refugees so until they arrived the fire spread even more. There is a huge problem with the equipment, because there is a quality control every two years on the fire-extinguishers and the rest of the equipment, but the reality is that a lot of times the foresters aren't given a lot of the equipment or if it's given it's in a bad shape, the fire-extinguisher present at the *Forest range Nr.8* for example was 7 years old, so a lot of times the foresters are basically forced to buy from their own sources the equipment, or in case of a fire to ask the foresters from the nearby ranges that have that equipment to help them. Even though Moldsilva receives money from the State every year – corruption remains the biggest problem, as with a lot of things in Republic of Moldova, a lot of the money is not being used in a right way. There is present a lot nepotism inside the structure so most of the people cannot talk freely about these issues.



## 7.0 Conclusion

Even though Republic of Moldova has a relatively low degree of afforestation, the importance and the impacts that forestry has on all aspects of life cannot be undermined. Although the economic development of the Republic of Moldova has contributed to some extent to poverty reduction and prosperity promotion, poverty still remains a problem for a big part of the population, which survives about US \$ 5 per day or less. Of the 40% that represent the poorest population, the majority live in rural areas. Many rural households depend on forest, which is an important source of wood for heating and preparing food, as well as a source of non-wood forest products. Poverty is a legacy that a lot of post-soviet republic are facing and which has a lot of further ramifications, one of the major ones being corruption. Republic of Moldova was always known for the highest rate of corruption in Europe and unfortunately it affects most of the institutions of the country, including forestry. This corruption is exacerbated by the presence of just one institution that is responsible for all the aspects of the forestry in the country – Moldsilva Agency. A lot of misgivings, corruption and cases of nepotism that are happening in the present days can be traced back to the Soviet times and unfortunately not a lot of this negative habits are willing to go from the institution. This obviously has a major impact on all forest management activities as well as forest protection activities, including forest fire-fighting ones. Based on the subjective assesment of the practical part of this thesis it can be concluded that a lot of laws, protection mechanisms and logistics in fire-fighting are not being respected at all, especially it can be seen from the logistical point of view- lack of fire-fighting equipment and inadequacy of response to fire is astonishing from an European point of view and even though in this thesis just one district from the Republic of Moldova was visited, it can be assesed that similiar situations are happening throughout all the country. The inspections l on the fire-fighting equipment that the Agency are carrying throughout its sub-ordinate entities ( such as forest districts, forest ranges) are inadequate and not very useful as it can be concluded from the subjective information gathered from the foresters working there such as : a lot of the equipment is bought and privately owned by the workers; the quality control of all the equipment every two years is just a superficial check that needs to be done on papers; in case of a fire happening in forest ranges that doesn't have the necessary equipment – the foresters have to contact the nearby ranges to ask for assistance from other foresters that have this equipment, this is in case the

emergency situations cannot be reached ( and this can happen a lot of times because the fire-fighting brigades are not that numerous, especially in poorer districts). Judging by the *Tables 7,8 and 9*, it can be noted that Moldsilva Agency is receiving adequate amounts of resources on lots of fire-fighting ,fire-prevention, instructive and educational activities, but unfortunately because of corruption a lot of this money is not being used where its needed so the efficacy of fire-fighting and fire prevention potential is a lot reduced. The common people are also a factor that contributes negatively to the situation because of their lack of awareness, judging from the thesis it can be concluded that most of the forest fires that are happening in the Republic are caused by the negligence of people in agricultural activities – the burning of agricultural lands for regenerative purposes, which should always be done in accordance to the laws and safety regulations under the watch of fire-fighting brigades, but unfortunately this happens very rarely and people are doing this activities by themselves therefore raising the chance of forest fires by a lot. Another factor that is contributing negatively to the situation is the natural one. The impact that climate change has on the forests and the dynamics of forest fires in Moldova can be felt quite strong, especially the rising of temperature, less frequent rainfall which lead to more frequent droughts and in turn lead to a higher chance of forest fires. This dynamic can be confirmed by the abundance of forest fires in the last years. So in order the somehow mitigate these negative factors a lot of measures should be taken such as : the raising of awareness of the population in regards to the unsafe activities that are performed on agricultural lands, reforms in forest sector and especially in the Moldsilva Agency, liquidation of corruption in the Agency and adherence to European laws in regards to the forest fires.

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