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Managing National Parks in the Czech Republic: Economic Analysis

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Abstract: Currently, the territorial conservation in the Czech Republic focuses on protecting extensive parts of land, more specifically large-scale areas. In terms of Act No. 114/1992 Coll., on nature and landscape protection, the category of large-scale protected areas includes national parks and protected landscape areas. In the Czech Republic there are four national parks (Krkonoše Mountains National Park, Šumava National Park, Podyjí National Park and Czech Switzerland National Park) covering 119,498 hectares, which represents 1.51% of the country's area, forest coverage of these being 87%.

To meet the needs of conservation, forests in national parks require special modes of management. Although not eliminated in these areas, economic activities or other human interventions are regulated so that all values and functions are preserved and, if possible, increased. Management of forests in specially protected areas has always been a subject of discussion between various interest groups. Currently, management techniques being applied in zones 1 and 2 of national parks, where they use close-to-nature forest management, present the most frequently discussed issue. The question is namely whether or not and to what extent it is necessary to intervene in the particular case before it is appropriate to leave the respective part of forest to future spontaneous development, as well as under what pre-requisites and after what time it can be effective. To decide which method of management to choose for the respective part of the forest, it is necessary to define the objectives to be achieved by such management. State administration or management in the national parks is conducted by park offices. From an administrative aspect, this involves state allowance organisations (Krkonoše Mountains National Park Administration, Šumava National Park Administration and Podyjí National Park Administration) and state government department (Czech Switzerland National Park Administration), with the legislation set out by the Act No. 218/2000 Coll., on budgetary rules, and Act No. 219/2000 Coll., on property of the Czech Republic. Each of the national park administration's founders is the Ministry of Environment of the Czech Republic and they are funded largely from the national budget. This paper aims at analysing the administrative offices of the national parks in terms of economics, focusing on their financial operations and management, as well as the economic impact of expanding the non-intervention areas in the national parks.

Keywords: Economics, national parks, nature conservation, state administration, forest management

1. Introduction

Specially protected areas (SPA) form one of the most popular and probably the most effective instruments to achieve conservation objectives and play a vital role in supporting local, national and international policies on biological diversity, and thus require to be managed in an effective manner. In the Czech Republic, emphasis is currently placed on protecting large specially protected areas, which chiefly involves national parks (NP) and protected landscape areas (PLA). From the conservation aspect, the Act No. 114/1992 Coll. on the protection of nature and landscape presents the main piece of legislation. Currently, the territory of the country contains four national parks, with offices of the respective parks being in charge of operations. This covers the Šumava National Park Administration (SNP Administration), Krkonoše Mountain National Park Administration (KRNAP Administration), Podyjí National Park Administration (Podyjí NP Administration) and Czech Switzerland National Park Administration (CSNP Administration). Management in national parks is influenced by natural and weather conditions, the extent of forest cover, the size and the type of legal entity. One of the key issues in national parks is often a conflict between protection of natural processes within the park territory (the non-intervention principle) and protection of biodiversity, despite the fact that these two parameters are the primary purpose of the existence of national parks in the Czech Republic.

This paper aims at an economic analysis of financial operations and funding of national park administrations, whilst also focusing on the forest management and indicating the economic impact of extending the non-intervention areas within Šumava National Park.

2. Forests, zoning and management in national parks

Currently, forest in the Czech Republic spreads over 2.6 million hectares, which is 34% of the area of the country. In the existing specially protected areas with diverse levels of protection, forests cover 749.6 thousand hectares, which represents approximately 28.83% of the country's total forest area (MoA, 2010). In national parks, the area of land designated for forestry is 103 thousand hectares, this representing a forest cover of 87.7%.

The system to assess forests in the country's SPAs employs three levels of classification, i.e. original, natural and near-natural forest. Original (primeval) forest is one that to some extent has remained unaffected by humans, with local woody plant composition and spatial structure corresponding to the conditions on the site. Original forest may even refer to vegetation that was previously affected by humans, but the intervention had no effects on deviating from the natural development trajectory and traces of such intervention are not obvious. Natural forest refers to one that was formed through natural processes, but was under human control in the past. The woody plant composition as well as spatial and age structure of this type largely corresponds to the site conditions, which however may differ in some spots, e.g. due to spontaneous development taking place in different conditions. Near-natural is a term for a forest, the species composition of which chiefly corresponds to the site conditions, with however the spatial structure being rather simple compared with that of the original forest. Such types of cover emerged under the influence of humans, who might have achieved the condition of these even consciously. (Vrška, Hort, 2008) The extension of such types of forest is shown in the table 1.

The territory of the Czech Republic comprises 29,556.64 ha of natural forests, of which 50% are located in national parks. The largest representation in national parks is one of near-natural forests (55% of the natural forests), with original forests being the least represented on the other hand (15%). The original forest and natural forest category is used to indicate forests left to spontaneous development over a long term, meaning that this applies to 6.7 thousand hectares of forests in national parks.

Methods and ways of protecting national parks are classified based on the national park territory zoning, which usually comprises three conservation zones with respect to natural values (zone I. – strict protection, zone II. – controlled, and zone III. – marginal). The most stringent mode of protection is stipulated for zone 1. (§ 17, Act No. 114/1992 Coll.) This zone is marked in the field and indicated in maps. Zoning is thus a division of protected areas based on habitat quality.

Division of the territory into zones is not one that follows types of management. The Act on the Protection of Nature and Landscape does not provide for principles of management to be applied in relation to particular zones. Zoning just relates to assessment of habitats and evaluation of the area. Furthermore, buffer zones can be declared for national parks, which place limitations for some activities, such as construction, thus protecting the national park from harmful external impact. Zones of protection and buffer zones are listed in the table 2.

Table 1 The extension of natural forests in national parks (ha)
Source: VÚKOZ, 2011

National park	NP area	Area of forest land	Original forest	Natural forest	Near-natural forest	Total
Šumava NP	68 064	54 100	375,91	3 267,51	6 393,39	10 036,81
KRNAP	54 969	36 300	1 781,44	788,47	10,43	2 580,34
Podyjí NP	6 283	5 270		336,16	1 559,81	1 895,97
Czech Switzerland NP	7 933	7 621		117,83	72,60	190,43
Total	137 249	103 291	2 157,35	4 509,97	8 036,23	14 703,55

Table 2 Zoning of national parks in Czech Republic
Source: Simon et al., 2010; *data from the NP Šumava

National park	I. zone (ha)	II. zone (ha)	III. zone (ha)	Buffer zone (ha)	Total (ha)
Šumava NP *	8 807 (12,9 %)	55 885 (82,1 %)	3 372 (5,0 %)	PLA Šumava	68 064
KRNAP	4 503 (8,2 %)	3 416 (6,2 %)	28 408 (51,7 %)	18 642 (33,9 %)	54 969
Podyjí NP	2 218 (24,5 %)	2 262 (25,0 %)	1 779 (19,6 %)	2 797 (30,9 %)	9 056
Czech Switzerland NP	1 653 (20,8 %)	6 210 (78,3 %)	70 (0,9 %)	PLA Labské pískovce, Lužické hory	7 933

The highest level of protection in zones 1 of NPs applies to 5,117 hectares of forest. Currently, forestry systems in protected areas can be classified as sustainable and near-natural forest management systems (FMS) that are designed to perform three basic functions of the forest, i.e. economical, ecological and social function.

In addition to protection zones, territory of each national park is subdivided based on the mode of management that sets a differentiated way of caring for forests with respect to the current condition of ecosystems, while respecting nature protection zones (Simon et al., 2010). This subdivision is not directly linked to protection conditions related to the territory unlike with zoning, but sets the way of current and future management. The subdivision to zones per type of management is based on the Methodological Instruction of the Ministry of Environment (MoE, 2006). The starting point for this is not just the current level of naturalness of forest ecosystems, but also the effort to keep the area compatible with that type of management. Based on that classification, forest territories split into areas left to spontaneous development (A), temporary management areas (B) and permanent management areas (C).

In line with the classification of the World Conservation Union (IUCN) applied to national parks, management in national park forests should seek to achieve prospective targets, with all ecosystems on 75% of the national park area being left to spontaneous development. This area should form the core zone followed by the buffer zone to protect the core zone from negative influences coming from the neighbourhood of the park.

3. Economics of national park administration

Administrations of national parks are in terms of legal form either state allowance organisations (SNP Administration, KRNAP Administration and Podyjí NP Administration) or a state government department (CSNP Administration). Each of them is a non-profit organisation that operates under the Act No. 218/2000 Coll. on budgetary rules, meaning that profit is not the primary objective. Administrations of national parks manage the assets assigned by their founder, which is the Ministry of Environment of the Czech Republic. Acting in matters of ownership rights is regulated by Act No. 219/2000 Coll. on the property of the Czech Republic and conduct of the same in legal matters. The organisations manage the state budget resources as provided by the administrator of the budget, i.e. the founder, within the founder's budgetary section. According to the Act No. 218/2000, their scope of activities is defined by their foundation deeds and splits into principal activities related to the organisation's mission, and economic activities. As regards the principal activities, the budget is compiled as a balanced budget. Economic activities are carried out outside the principal activity, and cannot produce loss at any event. Since economic activities are reduced to minimum in each of the organisations, representing about one percent in proportion to the principal activities, the figures given onwards refer just to principal activities conducted over the 2005 – 2009 period.

The state allowance organisations (SAO) are legal persons, with costs and revenues being their budget indicators. The state government department (SGD) is not a legal person and prepares its budget for income and expenditures. The SGD's income does not form revenues of the same and cannot be used to fund that organisation's spending, but must be transferred to the national budget.

Within the defined budget of national park administrations, one must distinguish between the costs (expenses), which are attributable to running the organisation (e.g. salaries) and those earmarked to caring for the natural systems within the park. The amount of costs (expenditures) of national park administrations is influenced to the greatest extent by weather, since the park territories mainly consist of forest, with forestry operations being their largest cost item.

During the reporting period, the total costs (expenses) of national park administrations ranged from 733.4 to 1,409 million CZK, reaching their peak in 2007, which was caused by eliminating the consequences of hurricane Kyrill. Since the managed territories vary per organisation, equivalent costs (expenses) per hectare of the protected area will be a figure of a higher reporting value, this amounting within the 2005 – 2009 period to the average of 7.5 thousand CZK per hectare of the protected area. The lowest cost (expenditure) in each of the years was that found in the KRNAP Administration, while that of the CSNP Administration was the highest. The greatest impact of hurricane Kyrill was that on the administration of SNP, with the equivalent cost per hectare of the protected area reaching 13.43 thousand CZK in 2007.

The largest cost (expenditure) item covers other services, with these accounting for approximately 30% in NP administrations in the form of state allowance organisations, and 45 – 50% for the state government department, of which the portion of timber transporting and skidding is the largest. To ensure diverse types of services, NP administrations use outsourcers. This is especially the case of ensuring cleaning in buildings;

work in the forest (such as logging, skidding, reforestation, forest protection etc.); employee training; repair and construction of buildings; repairs of road networks etc. The administrations award framework contracts to a range of contractors, with the percentage varying by size of the administration, and reaching 35% for the small administrations (Podyjí and CSNP), with the rate decreasing in the case of large administrations (Šumava and KRNAP) and amounting to more or less 15% of the principal activity. Growing, logging and other forestry activities are conducted within the small administrations through sole traders and small businesses, whose number is not fixed, while large administrations use also larger businesses to ensure growing and logging operations.

Staff costs (expenses) are another significant item, this including payroll costs (expenses), cost (expenditure) of social and health insurance, generation of the fund for cultural and social needs and other personal expenses. Staff costs (expenses) were accounting on average for 34% of the total costs (expenditure) during the reporting period. Payroll costs (expenses) throughout administrations move on average around 25%.

The proportion of direct and overhead payroll costs was also subject to determination. Since the national park administrations are not manufacturing enterprises, the share of direct and overhead costs is difficult to determine. Direct payroll costs can be considered to be those related to employees in handling stores and associated timber production premises, or also to workers in the forestry operations, the portion of which from the total number of employees in the KRNAP and SNP Administrations is approximately 15%. Small NP administrations employ staff engaged in professional activities, so it can be stated that in terms of ensuring the management these pay only for overhead payroll costs.

Revenues of state allowance organisations from principal activities consist of those from own activities and contributions/subsidies for the operation. Revenues of the state government department constitute revenues of the national budget, so therefore cannot be used by the organisation to ensure the normal operation.

During the 2005 – 2009 period, total revenues (income) of national park administrations ranged from 701.0 to 1,389.6 million CZK, with the highest amount being that of 2007, owing to the handling the timber mass after the calamity caused by hurricane Kyrill. In 2008, a decrease was recorded due to the lack of wood and in particular due to the collapsed timber market.

From this point on, the paper focuses only on revenues of national park administrations existing in the form of a subsidised organisation. The average of these per hectare of the protected area was moving around 7.3 thousand CZK/ha. The largest portion from the revenues is one of co-funding and subsidies for operations, this ranging on average from 50% to 70%, with the highest figure being that of the Podyjí NP Administration, while the lowest volume being that of the

SNP Administration. Subtracting the co-funding and subsidies for operations produces revenues from own activities, of which revenue from sales of timber is the largest item. Table 3 presents data on logging, realization, revenues from sales of timber and the average timber realization per national park administration (subsidised organisations) over the 2005 – 2009 period.

Revenues from sales of timber accounted on average for 28% of total revenues and 95% of revenues of own products. In 2006, the highest average timber realization was identified in the case of SNP Administration. The 2007 was positive in terms of prices of timber as regards each of the national park administrations as well as the country as such, with the largest average value of the average timber realization found in that year in the Podyjí NP Administration (1,102 CZK/m^3), while the SNP Administration saw in the same period a decrease in the value of the average monetisation down to 1,062 CZK per cu m. In 2008, there was a rapid annual decline of average timber realization, this affecting all NP administrations as well as the entire country, which was due to overall crisis of sales throughout the forestry and timber sectors and the consequent reduction in the average prices of wood, this amounting to 20-30% depending on the type of range.

Table 3 The development of logging and timber sales in the administrations of NP
Source: Data from Annual reports of administrations of national parks

Adnimistration of NP	Year	Revenues from sales of timber (thous. CZK)	Share of total revenues (%)	Share of revenues of own product (%)	Logging (m^3)	Realization (m^3)	Average timber realization (CZK/m^3)
SNP Administration	2005	132 131	37,43	94,34	139 376	117 062	1 124
	2006	103 938	32,08	92,84	108 359	92 062	1 129
	2007	617 236	66,30	98,21	767 143	581 213	1 062
	2008	249 631	41,06	95,96	163 928	135 148	878
	2009	118 702	23,76	98,94	311 106	249 732	1 000
KRNAP Administration	2005	83 397	26,60	93,80	91 016	90 667	920
	2006	82 559	26,28	94,37	88 935	87 236	946
	2007	104 734	26,71	91,02	108 292	105 841	990
	2008	70 010	19,91	92,25	83 376	85 180	786
	2009	66 923	19,16	92,11	93 244	78 625	890
Podyjí NP Administration	2005	8 264	18,70	95,12	8 437	9 506	869
	2006	9 025	20,47	95,74	10 069	10 692	844
	2007	10 221	21,24	93,44	10 122	9 272	1 102
	2008	8 027	15,44	96,46	10 436	8 548	939
	2009	9 908	18,17	95,28	9 525	11 389	870

Table 4 The expenditure of the administrations of national parks
Source: MoF, 2011a, 2011b, OS...own sources of funding

Administrations of NP	2005		2006		2007		2008		2009	
	thous. CZK	% OS	thous. CZK	% OS	thous. CZK	% OS	thous. CZK	% OS	thous. CZK	% OS
SNP Administration	379 258	45,9	356 773	40,3	943 915	70,8	535 840	34,4	634 954	48,3
KRNAP Administration	338 275	39,5	392 897	41,2	477 046	36	381 297	32	349 185	28,9
Podyjí NP Administration	45 323	30,7	46 869	33,1	53 863	31,1	64 418	18,9	69 801	17,9
CSNP Administration	51 634	x	55 603	x	62 062	x	81 929	x	87 156	x
Total	814 490	38,7	852 142	38,2	1 536 886	46	1 063 484	28,4	1 141 096	31,7

Although NP administrations are not timber companies, and therefore are not dependent on the sale of wood, income from sales of timber represents about 20% of total revenue of these and any decline has a major impact on the institution's budget.

In 2009, there was a slight improvement in realization of timber. Prices of timber were stagnating, thus the same applied to average timber realization.

In the Czech Republic, the state budget presents the main source of funding for administrations of national parks. Other funds flow from sources of the European Community, the State Environmental Fund, administrative regions, donations or other sources.

The activities of the organisations can be divided into operating and investment, with resulting expenditures on these activities. Total sources of funding in the activities above can be divided in subsidised organisations into institution's own resources and co-funding/subsidies, while funding as regards the state government department runs solely on co-funding and subsidies.

The table 4 presents the total numbers as regards sources of funding, while also providing percentage of own funding resulting from own activities in subsidised organisations that are funded this way.

Total expenditure on management of national parks in the Czech Republic ranged from 814.5 to 1,536.9 million CZK, with total co-funding and subsidies covering 52.4% of the total expenses. Own sources of funding were covering 36.6% of total expenditure as regards the NP administrations in the form of subsidised organisations.

4. The economic impact of extending non-intervention zones in Šumava NP

National parks provide many benefits. However, they must be managed in an efficient manner by the administrations to fulfil each of the park functions. If national parks are to be included in the IUCN's category 2 (i.e. national parks), expanding the size of their non-intervention areas is necessary. In order to achieve the target of 75% of the area included in the core zone and the subsequent buffer zone, an active management needs to be implemented in the core zone, which will be based on the condition and needs of each ecosystem in this area.

Since the management in Šumava National Park has been currently subject to the most extensive debating in the Czech Republic, some of the economic impacts that the non-intervention areas in this park bring along are discussed below.

The SNP area is 68,064 hectares, with the Šumava Protected Landscape Area (99,624 hectares) forming the park's buffer zone. The non-intervention areas are established within 16,674 hectares, which consists of 135 local fragments. The zone I. of the national park occupies an area of 9,003 hectares. The total area of forests in the park is 48,832 hectares, of which the non-intervention forest area is 15,815 hectares.

As regards Šumava NP, the ways of management are generally outlined by two legal regulations. This involves the foundation document of the NP (Government Regulation No. 163/1991 Coll.) and Act No. 114/1992 Coll. on the protection of nature and landscape, with none of these incorporating the "non-intervention" term.

The historical natural proportion of spruce within Šumava National Park was amounting up to 40%, and currently exceeds 80%. The reason for this is the presence of humans for centuries, the wind calamity of 1870 and the fragmentation of the non-intervention zones, this resulting in the development of low-resistant spruce monoculture (Lelková, 2011).

In 2007, Šumava NP was hit by hurricane Kyrill, this resulting in 744,440 cubic metres of windbreak wood being processed within the park just during the year 1, and 229 thousand cubic metres of wood remaining in zone 1 and zone 2 forests within seven windbreak areas without any intervention against the spread of bark beetle in addition to the treated timber. These intentionally unmanaged areas became a huge source of spread of bark beetle. With those effects being multiplied by another wind calamity, windstorm Emma, there was subsequent concurrence of the considerable bark beetle element of 2007 (numbers of wintering beetles) and abnormally warm spring with scattered and untreated windbreak areas affected by Emma in the non-intervention forests, this resulting in the onset of bark beetle calamity. (Martan, 2011)

Differentiated manners were employed to address the effects of hurricane Kyrill, with three basic modes of management being established in the NP forests: keeping spontaneous development, temporary interventions and repeated interventions over a long term.

Over the 2007 – 2010 period, a total of 1.895,000 cubic metres of wood were attacked in the forests managed by SNP Administration, i.e. those owned by the state, of which 767 thousand cubic metres were located in the intervention area and 1,128,000 cubic metres were found in non-intervention areas, this including the second beetle swarm in 2010. As regards the other owners, the status was as follows: 133,662 cubic metres attacked in the forests of the town of Kašperské Hory, 9,570 cubic metres in the forests of the town of Volary, 3,592 cubic metres in the forests owned by the town of Rejštejn and 4,000 cubic metres (estimation) affected in forests of minor owners (395 ha).

The total number of cubic metres of standing trees attacked by bark beetle throughout Šumava NP from Kyrill hurricane until the end of 2010 was 2,045,824. The number represents the equivalent number of trees at an average mass of one cubic metre per tree (Martan, 2011).

The 2009 brought along gradation of bark beetle populations in many parts of the park as was expected. In connection with the above, multiple increases in the mass affected by bark beetle being cleared was recorded in the intervention areas, with 186,501 cubic metres sanitised by debarking at the locality at the stump. The development of bark beetle salvage logging over the 2005 – 2010 period is shown in the figure 1.

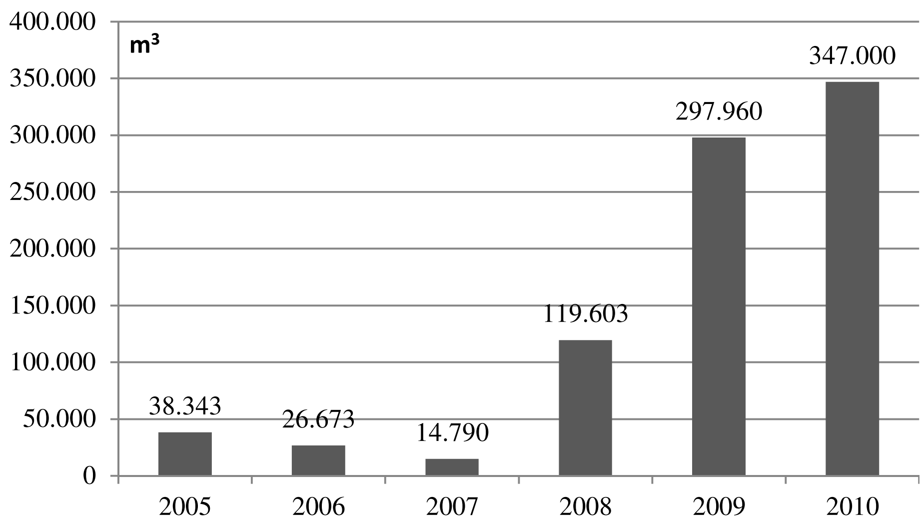

Figure 1 The development of bark beetle salvage logging
Source: Lelková, 2011

The increased rate of attacking forest stands by bark beetle resulted in increased use of harvester technology being employed throughout Šumava NP, which in 2009 processed 40% of volume of random bark beetle logging.

The extent of non-intervention territories and the large extent of untreated wood after the wind calamity as well as the bark beetle calamity in the NP have a negative impact even on forests of neighbouring owners, which is evident in significantly higher volume of bark beetle timber being harvested. In addition to environmental impacts, this has an economic impact as well.

The economic loss when selling one cubic metre of bark beetle timber ranges from 300 to 500 CZK. It is necessary to protect private forest adjacent to the park, which requires considerable logistical costs as well as the use of large quantities of personnel and funding.

Another fact is that natural regeneration can actually not occur in dead forests. Any artificial recovery increases the cost of reforestation and is as such an issue because of the large clearings that exist in the NP area, with 1,598 hectares of these coming into existence over the 2007 – 2010 period. Artificial recovery also gives rise to nothing than just even-aged stands.

In connection with the bark beetle calamity, many forest functions were compromised, be that recreational, soil and water management, health and hygiene or climate function, to name a few, with subsequent worsening of the quality of life of inhabitants and users of the respective parts of the landscape. The cases of loss and damage can incorporate those caused to entrepreneurs and local residents. To assess whether the died-back forest cover and bark beetle timber logging have resulted in any environmental damage, an estimate of environmental damage can be applied.

It can be estimated that the damage to the environment is in the order of billions of CZK. Should accurate information regarding the damage to specific forest stands be sourced, the estimate can be specified or proved by an expert opinion.

5. Conclusion

When comparing the operations of national park administrations, it was shown that the cost of timber transporting and skidding represents the largest cost item, followed by payroll costs. The largest portion of revenues consists of co-funding and subsidies from the founder and sales of own products, especially income from sales of timber. Funding operations of administrations of specially protected areas is carried out in subsidised organisations by combining revenues with co-funding and subsidies, while the same in the case of state government department takes place solely in the form of co-funding and subsidies.

Assessing an economic impact of non-intervention areas is very difficult. Tackling the issue of which environmental criteria to apply when deciding whether the forests in specially protected areas should be left to spontaneous processes or not is based on knowledge of the patterns of original and natural forests, especially on consideration of their basic characteristics and properties.

The expansion of non-intervention zones and natural conditions in Šumava National Park results in environmental damage, property damage, losses when selling the bark beetle timber, damage from disturbed performance of the functions of protected areas, economic losses of entrepreneurs as well as local residents etc.

Efforts to improve treatment of Šumava nature and its forests are not based on the necessity of logging; they also do not support logging companies. Sensible, moderate and thoughtful logging that leads to protection against bark beetle and other harmful agents and allows successful natural regeneration of forest under the protection of adult living forests is the very approach that Šumava NP will have to adopt.

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Forest associations of the National Park Mavrovo in the Republic of Macedonia

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Abstract: In this scientific paper are observed data related to research conducted of the phytocoenological characteristics of the territory of the National Park Mavrovo in the Republic of Macedonia. Therefore, visited and explored were the mountain massifs: Shar Planina, Korab and Bistra. Within the completed surveys, the standard phytocoenological method of *Braun-Blanquet* was used. On the teritory of the Park, authors noted and identified 28 forest communities (19% of the 148 identified plant communities in the Republic of Macedonia), i.e. 4 coastal floodplain (riparian) forest communities, 18 typical forest communities and 6 degraded-coppice forests. Coppice forests until now have not been guided in the literature. Also were disclosed forests with virgin forest's character. In addition to natural forest communities, listed are artificial forest stands. Likewise, were discovered new data of certain phytocoenological phenomena, as in the Park, and in Macedonia. New insights arising from this research are particularly important, taking into account the rapid progress of studies on vegetation in Europe (creating ecological networks) and thus solve the important forest ecosystem problems. Extensive scientific work will undoubtedly lead to the creation of a solid and relevant base of phytocoenological data that will provide the conditions for protection of significant forest communities in the Park and thus in Macedonia.

Keywords: forest association, forest community, forest ecosystem, National Park Mavrovo

1. Introduction

The National Park Mavrovo range of 3 mountain massifs- Shar Planina, Korab and Bistra, with an area of about 73,000 ha in north-westernmost part of the Republic of Macedonia. It is characterized by great floristic richness, particularly of dendroflora and forest communities. Part of this plant treasure has a rare, endemic and tertiary relict species (Simovski, 2011). In the paper are observed data related to research conducted of the phytosociological characteristics of the territory of the National Park Mavrovo. From previous research, that of the authors and their works listed in the references section, in addition to established scientists in the flora and vegetation, it is important to mention the research of Em (1959, 1961, 1962, 1967, 1974, 1985), Dzhekov (1962, 1985), Rizovski (1978, 1985, 1996, 1999), Nikolovski (1991), Micevski (1985, 1993, 1995, 1998, 2001, 2005), particularly those conducted within the Park. In addition to field research, the experts were able to consult with a solid database of existing literature. Of the 148 identified plant communities in the Republic of Macedonia (Rizovski, 1986), within the boundaries of the Park, paper's authors noted and identified 28 forest communities (19% of the 148 identified plant communities in the Republic of Macedonia), i.e. 4 coastal floodplain (riparian) forest communities, 18 typical forest communities and 6 degraded-coppice forests (*Tab.1*). Coppice forests until now have not been guided in the literature (Acevski & Simovski, 2010). Also was disclosed forests with virgin forest's character. Ass. *Salicetum cinerreae* B. Jov. 1953 was soaked with flooding of the Mavrovo field, when the dam was built (Dzhekov, 1962; Nikolovski, 1991). In addition to natural forest communities listed are artificial forest stands. New insights arising from this research are particularly important, taking into account the rapid progress of studies on vegetation in Europe (creating ecological networks) and thus solve the important systematic, synhorological, syndynamical, and synecological problems. Extensive scientific work, as well as consulting relevant literature in terms of classification (according to European programs and comply with their classification methodologies, such as NATURA 2000 - EUNIS, CORINE, etc. will undoubtedly lead to creation of a solid base of phytocoenological data. Furthermore, this will provide the conditions for protection of significant forest communities in the Park and thus in Macedonia, and identify some of the guidelines for the development of the PI National Park Mavrovo.

2. Materials and methods

The most important tasks of this research is determining, describing and

Tab. 1 List of the forest associations determined in the NP Mavrovo

Coastal floodplain/riparian forest communities	
Ass. *Tamarici-Myricarietum* Em 1976	Ass. *Fraxino-Alnetum glutinosae* Lj. Micevski 1978
Ass. *Salicetum incanae* Jov. 1963 (=*Epilobio dodonaei-Salicetum elaeagni* Em 1976)	Ass. *Aesculo hippocastani-Ostryetum* Em 1965
Typical forest communities	
Ass. *Querco-Carpinetum orientalis macedonicum* Rudski 1939 apud. Ht. 1954	Ass. *Seslerio-Ostryetum carpinifoliae* Ht. et H-ić 1950
Ass. *Querco-Ostryetum carpinifoliae* Ht. 1938	Ass. *Corylo colurnae-Ostryetum carpinifoliae* Blečić 1958
Ass. *Orno-Quercetum cerris macedonicum* Em 1964	Ass. *Orno-Quercetum petraeae* Em 1968
Ass. *Festuco heterophyllae-Fagetum* Em 1965	Ass. *Seslerio autumnalis-Fagetum moesiacae* Blečić et Lakušić 1970
Ass. *Luzulo-Fagetum macedonicum* Em 1976	Ass. *Calamintho grandiflorae-Fagetum* Em 1965
Ass. *Fagetum subalpinum scardo-pindicum* (Ht. 1938, Tregubov 1957) Em 1961	Ass. *Abieti-Fagetum macedonicum* Em (1962) 1985
Ass. *Abieti-Fagetum* subass. *Pinetosum nigrae* nomen nudum	Ass. *Abieti-Piceetum scardicum* Em (1958) 1985
Ass. *Fago-Abietetum meridionale* Em 1973	Ass. *Castanetum sativae macedonicum* (Rudski 1938) Nikolovski 1951
Ass. *Aceri-Fraxinetum excelsioris* Cernj. et B. Jov. 1950	Ass. *Aceri obtusati-Fagetum* Em 1965
Coppice forests	
Thickets of *Juniperus communis* and *J. intermedia*	Thickets of *Juniperus oxycedrus*
Thickets of *Cytisus leucanthus*	Thickets of *Corylus avellana*
Heaths of *Juniperus sabina*	Heaths of *Vaccinium spp.* and *Juniperus nana*

mapping the forest communities and their localities which are determined by the sites, assessing the degree of their endangerment, recommendations for their protection and other linkages with forests and forest communities within the NP Mavrovo. Within the completed surveys, the standard phytocoenological method of *Braun-Blanquet* was used. For conducting field surveys mostly are used topographic maps S=1:25000, satellite and aero photo imagery, GPS measurements and more, in the most part provided by modern forestry-geomatic laboratory techniques in GIS Lab at the University of Ss. Cyril and Methodious – Faculty of Forestry in Skopje.

3. Results and discussion

The forest communities are determined from the conducted field studies, and some of the most important forest associations are listed below, with an overview of their phytocoenological characteristics.

Ass. *Aesculo hippocastani-Ostryetum* Em 1965

G1.A46222 (EUNIS)

This arctotercieric relict and endemic community notes directly by the flow of river Garska Reka, with the largest population of common horse chestnut around the place called Tri Cheshmi (*Photo 1*). Almost all of the wild common horse chestnut trees because of its mesophilic nature, are next to the river at an altitude of about 830 m. Vegetation cover is thick. Despite the rocky carbonates due to the shadowy area, in fact by the accumulation of hummus soil layer by the river (river sediment soils) and humidity in the air, at the floor of the trees there are many tree species. The ground floor is represented by the typical species of coastal flora.

Ass. *Querco-Ostryetum carpinifoliae* Ht. 1938

G1.7C11 (EUNIS)

Represents one of the more commonly participated communities in the Park. It develops on steep slopes in areas where there is a conflict of the moderate cold climate area with submediterranean climate. It is a local environmental and orographic conditioned phenomenon. The geological background is mostly composed of Mesozoic limestone of which are formed shallow rendzinas or calcomelanosols. It conditions the emergence of calciphilic species adapted to these sites. Vegetation cover varies and is closely correlated with local site conditions. Forest vegetation cover ranges from 50 to 70%. At the most prominent forms of relief, where the soil is relatively shallow, almost always floor of trees is absent. However, on slightly inclined slopes, in valleys with higher relative humidity, as well as negative relief forms (shaped depressions, karstic fields, etc.), where by default the soil is deeper, clearly shows floor differentiation. At some sites this community is found on higher altitudes, i.e. 1000-1400 m altitude. At the floor of the trees are observed the following types: *Ostrya carpinifolia, Quercus pubescens, Q. cerris, Acer obtusatum, Tilia tomentosa,* etc. At the floor of the shrubs are found drought resistant shrubs. The greatest

Photo 1 *Aesculus hippocastanum*, locality Tri Cheshmi, NP Mavrovo

significance of this forest community is in its protective role.

Location: over the village Selce, place called Golubarnik above the forest road to the crest, hardly accessible terrain: very old trees of *Ostrya carpinifolia*, virgin forest.

Ass. *Seslerio autumnalis-Fagetum moesiacae* Blečić et Lakušić 1970

G1.69 (EUNIS)

This forest community in the Park is located in small rocky areas on western river flow of the Radika river. This forest is a locally environmental conditioned. Formed on carbonate rocks have the same characteristics of submontane beech forest, despite the fact that *Fagus sylvatica* ssp. *moesiaca* is met as an edificator. In ground floor vegetation is encountered the *Sesleria autumnalis*. The significance of the forest community is identical with the submontane beech forest, but because of the difficult accessibility it has features of a virgin forest.

Ass. *Fagetum subalpinum scardo-pindicum* (Ht. 1938, Tregubov 1957) Em 1961

G1.6913 (EUNIS)

This forest community in the Park occupies a relatively small area. On mountain Bistra it is encountered on the peak Veli Vrv, on a locality called Golem Bardezh. In addition, it is noted on Korab, in a very narrow band at high altitudes (above 1800 m), with small areas of many sites. The forest is developing at extremely roughly sites, primarily due to unfavorable climatic conditions (strong winds and heavy snow drifts). The forest is a border zone between forest and alpine meadows and is a frequent target of anthropo-zoogenic factor, i.e. cutting and destruction for the needs of farmers who graze livestock in the zone of alpine pastures. It settles carbonate and silicate rocks. The carbonate is observed mostly on calcomelanosols, and silicate - ranker.

Adverse climatic conditions have a strong impact on floral physiognomy and composition of this forest. Often going to the floor of the trees absent or it is with trees that are strongly deformed. The canopy closure, i.e. density of the forest usually establishes shrubs. From a wood production perspective, pre-alpine beech forest has no particular economic value, due to small area and small amount of wood volume. On the other hand, its ecological (erosive control) role is very significant, so these forests in the future will be protected. In recent years there is a noticeable expansion of these forests in elevation (amplitude) terms (up to 2000 m a.s.l.), and as a reason for this is the reduced number of pastoralists in the alpine pastures and global climate change (warming). It contributes to move (extend) the limits of beech pre-alpine community.

Ass. *Abieti-Fagetum macedonicum* Em (1962) 1985

G1.6A1 (EUNIS)

Beech-fir forest community in the Park is represented on major areas: the slopes of Bistra, Korab, and upper parts of r. Radika. To emphasis is that this forest community is in expansion, so in recent decades has expanded its range of distribution. It forms and settles on rock silicate substrate, usually on eutric and dystric cambisol and ranker, and on rock substrate of carbonate-brown soils on limestone and browned calcomelanosols. These forests settle expressed mesophilic sites in the zone of beech forest region of 1100 to 1600 m a.s.l., primarily in north, northwest and northeast exposure. Forests are densely assembled (canopy closure), from 0.9 up to 1. Beech-fir forest communities are characterized by clearly marked floral structure. The floor of trees is in absolute dominance of *Fagus sylvatica* ssp. *moesiaca* (Balkan beech) and *Abies borisii regis* (fir). At the floor of shrubs, because of the large forest canopy closure, the number of species is relatively small, and mostly characterized by shadetolerant species.

In these forests there is a clear hostility to the spread of fir, and it manifests itself mostly with high emergence of offspring. This results due to many factors, primarily on:

- ✓ Reduced antropo - zoogenic influence, especially in the last fifty years,
- ✓ Changing climate conditions and
- ✓ Changes in light regime across these forests, which requires and provides opportunity for fir, with high shade-tolerance, very easy to reproduce.

Based on the current state of these forests, we can conclude that in the past have been prevalent in many large areas, so today, when favourable conditions are on the horizon, again returned as one of the most productive, but also as a permanent stage of the syndynamic of these sites. Forests are with extremely high commercial significance, since they are most productive, easily renewable (large vegetative ability of the beech, great reproductive ability of the seed-fir) and importance in biodiversity.

Ass. *Abieti-Fagetum* subass. *Pinetosum nigrae* nomen nudum

This black pine stand occupies a very small area near Strezimir (Border Police Checkpoint). From a scientific standpoint, it is a very interesting phenomenon that deserves more intensive research to determine the reason for its propagation (primary or secondary origin). This stand has developed on silicate rock area, where the black pine (*Pinus nigra*) has no competition from other species, and adjacent to well-developed mesophilic beech-fir forests, and even had been seen individual trees of spruce (*Picea abies*).

Ass. *Abieti-Piceetum scardicum* Em (1958) 1985 G3.1E1 (EUNIS)

This forest community is one of the most interesting and most researched forest communities in the Park. Namely, the spruce-fir forest is interesting from several aspects. From synhorological aspect, this community represents the southernmost spruce forest in its European range (distribution). In this regard, it is found only in the basin of a river Adzhina Reka at an altitude of 1400 to 1800 m (*Photo 2*). The site characterizes with silicate base, on which are formed acid (acidophilic) - dystric cambisols, characterized by deep soil profile and good water-air regime. The spruce-fir forest is a relic from the last period of glaciation, recorded in these areas. There are a number of reasons

Photo 2 Ass. *Abieti-Piceetum scardicum*, locality Adzhina Reka, NP Mavrovo (withering of the spruce- *on the right*)

that conditioned the survival of this forest in this region to date, although it spent a long period of glaciation. As part of those reasons would be cited:

- ✓ Exposure, i.e. positioning of the woods, with north-northwest exposure, or is in constant shade,
- ✓ Climatic conditions, i.e. the area where the forest extends has a specific microclimate, characterized by relative high humidity of the air and soil throughout the year and the reason for this is that this area is a zone of so-called rain shadow, moist air masses that penetrate the Adriatic always cause heavy rainfall and snow and high relative humidity and
- ✓ Antropo-zoogenic impact, i.e. as a result of a rare population of this area was not subject to degradation processes (cutting, burning, uproot, destroy, etc.).

The spruce-fir forest has a clearly marked floral composition. Floor of the trees is characterized by large forest canopy closure and it is dominated by *Picea abies* (Norway spruce), which can reach heights up to 25 m, and *Abies borisii regis* (Balkan fir). At this floor there is very small presence of other species, primarily due to spruce-fir dominance and expressed shade tolerance. At the ground floor vegetation are encountered number of expressed mesophilic and acidophilic species.

The forest has great scientific significance which derives from its location in the overall distribution of spruce forests. Today, in it are observed processes of extinction, especially drying large number of spruce individuals (*Photo 2*). There is decrease in the population of spruce offspring, and an aggressive expansion of the fir. Reasons for this are many, and as a part of them are:

- ➢ Change of the microclimate and light regime in the population,
- ➢ Achieving the climax of the old spruce trees and
- ➢ Aggressive competition by fir.

These are only partial views of the reasons for reduction (disappearance) of the spruce of these areas. To discover all the reasons that contribute to the withering of this important scientific spruce forest, it is necessary to set up monitoring stations for detailed monitoring of all environmental factors and based on it will adopt appropriate and sustainable measures for further management and protection of these forests. As an indicator that there are major environmental changes in this area, will say that in the immediate vicinity of this forest has the appearance of species that are drought resistant species i.e. represent a steppe floral element (*Berberis vulgaris*), which unambiguously indicates alert to take timely measures to protect this rare forest. In the performance of field research, in the basin of the river Adzhina Reka, near the spruce-fir forest - concluded an initial stage of spreading of the Macedonian pine (*Pinus peuce*). Namely, from a single pine tree, with age of 30-40 years, with a height of about 10 m and reached reproductive maturity, there are clearly noticeable intense spreading offspring of 150-200 new trees with great vitality, which in the future will create

Macedonian pine forest with great scientific importance.

Ass. *Fago-Abietetum meridionale* Em 1973

Pure fir forests in the researched area, although they represented a small area, are an important phenomenon. They are found in several localities along the valley of the river Radika. This forest populates northern, northwest, western and eastern exposures, on steep slopes with altitude from 1000 to 1600 m a.s.l. Rock is mostly silicate and soils that are formed have extremely acidic reaction. Site conditions are characterized by strong mountain climate with mesophilic attributes. In the summer, there is no noticeable occurrence of summer drought. The forest of fir has a very dense canopy closure (0.9 to 1), where the floor of the trees is an absolute dominance of fir (*Abies borisii regis*). Very rarely are found single or small groups of trees of beech (*Fagus sylvatica* ssp. *moesiaca*), *Acer pseudoplatanus* and *A. platanoides*. The localities where this forest is in initial stage, also are observed pioneering remnants of *Prunus avium* and *Salix caprea.* Floor of shrubs is poorly differentiated due to the dense canopy closure. Ground floor vegetation is characterized by a small number of species. Pure fir forests have great economic importance because the timber has a great industrial value. A positive feature is that these forests are in progressive succession, with massive fir spread in dense closure of common juniper (*Juniperus communis*) thickets.

Ass. *Castanetum sativae macedonicum* (Rudski 1938) Nikolovski 1951 G1.7D (EUNIS)

Forest of sweet chestnut (*Castanea sativa*) takes up very little area. It develops in the vicinity of the village Skudrinje at the socket of Deshat Mountain, so you can say that there is anthropogenic nature of creation. Rock is a silicate, in which develop deep luvisol. In this forest are included many elements of pubescent oak-eastern hornbeam forest community. From physiognomic aspect is clearly visible the impact of man, so the trees have very wide branches and sparse structure. In these areas chestnut is a natural and has relict character. Therefore, this chestnut forest should be placed under protection.

Thickets of *Juniperus communis* and *J. intermedia* F3.164 (EUNIS)

Observed is phenomenon of spreading this type of degraded stage, especially in the zone of alpine pastures. Syndynamicaly, these thickets tend to be pioneering species to create conditions for development of forest vegetation, mainly depending on altitude, climate conditions and antropo-zoogenic factor. Around the settlements, on abandoned fields and meadows they represent a progressive process of development of forest vegetation. What type of wood will develop depends on the surrounding forest vegetation. Thickets have a protective (erosive control) role in preventing the erosion processes, so in the future should be given greater influence, as one of the important links in the development and expansion of forest vegetation.

Thickets of *Juniperus oxycedrus*

Unlike previous thickets, these thickets spread on thermophilic and expressed drought resistant sites in zones of influence of the Mediterranean climate, or on southern and carbonate sites. These thickets are part of natural succession in the progressive development of thermophilic oak forest.

Thickets of *Cytisus leucanthus*

These types of thickets commonly are observed on greater elevations in the zone of beech and subalpine beech region (1400 to 1900 m). It represents a pioneering stage, which usually develops at grazing floral communities, especially in areas with reduced intensive cattle breeding.

Thickets of *Corylus avellana*

Found on sites where in the past had been some fertile agricultural lands, which now occupy area on abandoned farmland (progressive succession) in the zone of *Quercus petraea* forest areas in the village Tresonche to the village Lazaropole, particularly in Lokvishte. Besides the common hazel (*Corylus avellana*), which builds very dense populations are found elements of the oak and beech forest elements. Depending on site humidity conditions, these thickets can evolve into oak or submontane beech forest. It clearly indicates that this area in the past was under forest, but man rearranged it for own needs.

Heaths of *Juniperus sabina*

The creeping juniper (*Juniperus sabina*) is a mountainous species which is widespead within the Park. It has wide ecological amplitude within the Park, from lower altitude up to 2000 m a.s.l. The creeping juniper is present almost in all forest ant pasture communities, but particularly on wide-open areas, covering rocky slopes.

Heaths of *Vaccinium spp.* and *Juniperus nana* G3.6 (EUNIS)

As a result of intensive livestock reduction, the conditions for the "wilderness" on alpine pastures emerge. One of these areas is more intensive development of the blueberry heaths (*Vaccinium myrtillus* and *V. uliginosum*) and mountain juniper (*Juniperus nana*). In the initial part of the river basin of Adzhina Reka within this heaths, in initial phase of development is found forest of the Macedonian pine (*Myrtillo-Pinetum peuces* Em 1962 = *Gentiano luteae-Pinetum peuces* Em /1960/ 1962), which indicates that heaths in the future, unless they are managed (pastures, burned, cut), can gradually switch (transform) in acidophilic coniferous forests.

Artificial forest stands

Although a national park, on the territory of the PINP Mavrovo there are artificially-planted areas in the immediate vicinity of the settlements, intended to protect against erosion processes. These areas/stands are raised in order for a short period to provide protection from erosion to the settlements. Newly planted forest stands now are in the form of forest plantations, age 30-40 years, which completely fulfilled the function for which they are raised, reducing the erosive processes. These stands are raised with native species, such as: black pine (*Pinus nigra*), Scots pine (*Pinus sylvestris*), spruce (*Picea abies*), and Macedonian pine (*Pinus peuce*).

4. Conclusions and recommendations

Arctotercier endemic and relict community of horse chestnut and hop-hornbeam

Although a small area covered by this community, because the horse chestnut is a tertiary relic and Balkan endemic species, and even more because of the uniqueness of this forest community in Macedonia, it is a phenomenon of great importance as for a natural and scientific value.

Progressive development of the fir and fir-beech forests

Based on the current state of the fir forests, we can conclude that in the past they have been prevalent in many large areas, so today, when favorable conditions again returned to the horizons, as one of the most productive, but also as permanent stages of syndynamics in these sites. Besides the economic importance fir forests have high ambient value, because they give the landscape alpine characteristics.

Black pine grove

This „forest" although in a small area, is a scientific phenomenon. With detailed research there could be an answer to its origin and development.

Spruce-fir forest

The spruce-fir forest is a relic from the last period of glaciations, recorded in these areas. The forest has great scientific significance which derives from its location in the overall distribution of spruce forests. Today are observed processes of extinction, especially withering large number of spruce individuals. To discover all the reasons that contribute to the drying/withering, it is necessary to set up detailed monitoring of all environmental / ecological factors and based on it will adopt appropriate and sustainable measures for further management.

Initial stage of development of the Macedonian pine forest

Further monitoring of the successive development of this initial stage of formation of the Macedonian pine forest provides excellent opportunities for scientific monitoring of dynamics and creation of new forest, as well as to take timely measures for its protection (impact of antropo-zoogenic factor). This forest community in the future will greatly contribute to forest biodiversity in the Park because it will increase the number of relict communities.

Forests with virgin forest's characteristics

Within some communities are found forests with virgin forest's character, and as builders or participants occur (very old): *Aesculus hippocastanum, Ostrya carpinifolia, Juniperus foetidissima, Acer pseudoplatanus, Fagus sylvatica* ssp. *moesiaca, Abies borisii regis*.

Increasing the area under thickets and heaths as part of a progressive stage of development of forests

The increase in area under these degraded stages is important for landslide care. Some of them are important for stimulating rural development in the local population. Some of them, however, are very important in preparing the ground for the emergence and development of economically important species and establishing a stable forest ecosystem.

Impact of antropo-zoogenic factor to the spread and increase of forest communities' area

With reduced human influence on, mostly, pastures, besides abiotic factors, there is inevitably increase or gradual expansion of forests. Parts of new areas under forest are, in essence, areas that previously were under the forest, so now again invaded the area. However, the activities of employees in the Park, guided by special plans for forest management, moderate and appropriate rejuvenate and refresh the existing forest areas, not letting it lead to a natural climax, which are increasing their productivity and quality, and thus create and improve conditions for development of forests as the most stable terrestrial ecosystems.

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The analysis of life quality indicators in the area of natural resources and environment protection in chosen micro-regions of the Czech Republic

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Abstract: Approved strategy of sustainable development of the Czech Republic is based on three pillars of defensibility, namely social, economic and environmental. The paper is focused on the third pillar that includes field of natural resources. It is solved at level of chosen regions and micro-regions in the Czech Republic. From the point of view of chosen indicators it is concerned with analysis of farm land, lands designated for serving as forest function and non-farm land and also of the coefficient analysis of ecological stability of landscape.
Furthermore in the paper there are also analysed chosen problems in the sphere of environment protection in particular regions and micro-regions of the Czech Republic. The analysis of environment protection is realized in years 2002 – 2008. Protection of environment is evaluated by indicators such as e.g. environmental assets and non-investment expenditures of environment protection.
Researching is based on time lines of data about development of partial indicators that analyse field of natural resources and environment protection in chosen four micro-regions. Coefficient of ecological stability (CES) is complex indicator that expresses quality of lands for guidance. Average value of this indicator is 1,04 in the Czech Republic. Regions that have value of indicator over the average of the Czech Republic are: region Liberec, Karlovy Vary, South Bohemia, Zlín, Pilsen, Moravian-Silesian and Hradec Králové. By contrast, under average value of the Czech Republic are Capital of Prague and region Central Bohemia, South Moravia, Vysočina, Olomouc, Pardubice and Ústí nad Labem. By comparison of average values of mentioned indicators according to regions and according to chosen micro-regions with data of the Czech Republic in 2006 it is clear that most of values of individual micro-regions are much more variable. For analysis of environment protection in chosen micro-regions there were also used indicators of emissions (REZZO 1-3), Indicators of average environmental fixed assets per capita and Indicators of average environmental non-investment expenditures per capita.

Keywords: Micro-region, natural resources, coefficient of ecological stability, environment protection, environmental assets and non-investment expenditures, disparities in regions

1. Introduction

Goals of the strategy of sustainable development in the environmental pillar are orientated to eliminate disparities, eventually reduce them at the most, not only among regions but also among municipalities. All of that is concurrently also in interaction with other two pillars of the mentioned strategy of sustainable development (Progress Report on the Sustainable Development Strategy of the CR 2009).

Total area of the Czech Republic (CZE) is 7.9 million hectares (78 866 km^2), there out farm land represents 4.3 million hectares (54%) and forests 2.6 million hectares (33%). In light of relief there mountains represent 12%, highlands 34%, hilly country 50% and lowlands 4%.

Area of farm land and non-farm land relatively stables in conditions of the Czech Republic. But their representation in individual regions is very different. It effect on quality of life in regions and micro-regions (Jánský 2008).

Environment protection belongs to very topical questions today. It is fact not only in worldwide or national basis but also individual regions, micro-regions, municipalities or business entities solve this question. Ministry of the Environment submitted so-called Report on the Environment of the Czech Republic to the government (Report on the state of the environment). The report states that state of the environment is getting better after previous stagnation in years 2005-2006. But it also concurrently emphasizes that fundamental problems and menaces for future development, identified already in preceding years, gain importance. They are concerned growing emission of greenhouse gas, high share of airborne release from hardly controllable sources of pollution (traffic and house heating) and dynamic development of road transport that is connected with adverse impacts upon environment.

2. Materials and methods

The paper brings elaboration of analysis of disparities in the environmental pillar, especially in the field of natural resources utilization in chosen micro-regions of the Czech Republic. It is focused especially on indicators of structure of land using in regions and in their individual municipalities.

Researching is based on time lines of data about development of partial indicators of land utilization in municipalities and analyzes their complex formulation through coefficient of ecological stability. This coefficient represents relatively simple and concurrently measurable data not only on regions and rural district scale but also in individual municipalities.

In the next part of the paper there are analysed chosen problems in the sphere of environment protection in regions and districts where chosen micro-regions are situated. The analysis is realized by use of chosen indicators. Statistical data of environment protection are presented for individual regions and districts, not for micro-regions and municipalities. With regard to this fact, environment protection in certain micro-regions results from statistical data and indicators of appropriate districts where are micro-regions situated.

The paper analyses e.g. indicators such as environmental assets, environmental non-investment expenditures and emission in years 2002 – 2008.

Approach to environment protection is also analysed by use of questionnaire investigation. Questionnaires are completed by municipality's mayors of all municipalities and by chosen citizens of municipalities belonging to particular micro-regions.

3. Results and discussion

Similarly, as in regions and rural districts of the Czech Republic is possible to evaluate life quality in the field of natural resources, it is possible to evaluate this field also in chosen micro-regions and their municipalities through specific indicators.

Evaluation is only adequate because indicators application is relative in some view. While some indicators are explicitly identifiable and measurable on the region and individual municipalities scale, other indicators aren't.

On the other hand, it is possible to better express certain specifics at the level of region and especially according to municipalities. Significance of these specifics and their evaluation on the higher level (e.g. through average values of region) is only informative. It can be e.g. evaluation of municipality from the view of location for mining of mineral material in municipality cadastre, hazardous waste dump etc.

Analysis of disparities development in the environmental pillar

Analysis of disparities development in the environmental pillar is realized through indicators focused on environment protection.

In the next part of the paper there we concentrate on analysis of ecological stability coefficient of landscape, on percentage of ploughed farmland and on significance of forest land.

Coefficient of ecological stability (CES) is complex indicator that expresses quality of lands for guidance. It represents index number that sets ratio of stable elements of landscape formation (vineyards, hop-gardens, gardens and fruit groves, permanent grass stands, forest land and water area) and unstable elements (arable land, built-up areas and other areas) (Report on the state of the environment). The higher value of mentioned indicator the more ecologically stable is the landscape.

Average value of this indicator in the Czech Republic is 1.04. Regions that have value of indicator over the average of the Czech Republic are: region Liberec, Karlovy Vary, South Bohemia, Zlín, Pilsen, Moravian-Silesian and Hradec Králové. By contrast, under average value of the Czech Republic are Capital of Prague and region Central Bohemia, South Moravia, Vysočina, Olomouc, Pardubice and Ústí nad Labem. Values of this indicator of ecological stability and rate of ploughing shows table 1.

Tabel 1 Comparison of chosen indicators of land utilization structure in regions of the Czech Republic and in chosen micro-regions in 2006 (in %)

Region – micro-region	Rate of ploughed farmland	Coefficient of ecological stability
Czech Republic	71.44	1.04
Capital Prague	73.45	0.30
Central Bohemia	83.16	0.66
South Bohemia	64.52	1.45
Pilsen	68.80	1.32
Karlovy Vary	45.08	1.94
Ústí nad Labem	66.55	0.96
Liberec	48.68	2.18
Hradec Králové	69.10	1.03
Pardubice	73.16	0.89
Vysočina	77.44	0.84
South Moravia	83.20	0.67
Olomouc	74.45	0.98
Zlín	64.32	1.41
Moravian-Silesian	62.89	1.30
Micro-region Běleč - Pilsen region	74.01	0.92
Micro-region Lučina - Pilsen region	60.41	3.22
Micro-region Podluží - South Moravia region	82.87	0.68
Micro-region Hranicko - Olomouc region	77.02	0.55

Source: CSO, own calculations

By comparison of average values of mentioned indicators according to regions and chosen micro-regions with data of the Czech Republic (1.04) in 2006 it is clear that most of values of individual micro-regions are much more variable.

Classification of CES according to Míchal (1994) is based on clear and final formatting of landscape element into stable or unstable group and it doesn't enable to evaluate concrete state of these elements. Within forest management of the Czech Republic it is possible to find differentiation of ecological important e.g. in the law No. 289/1995 Sb. about forests – in case of methodology of charges calculation for depriving of forest land on the base of forest categorization – respectively through the factor of ecological weight of forest. This factor has value 1.4 in case of production forests whereas it takes the value 3.0 (forests in extra adverse stations) to 5.0 (high-elevation forest under limit on tree vegetation) in protection forests. Forests of special determination have accordingly value 5.0 (e.g. forests in water sources I. protection zone, forests of national parks – 1. zone, forests in especially protected territories, forests in system of ecological stability of territory).

As *indicators focused on environment protection* in chosen micro-regions are possible to use following indicators:

- Indicator of emissions (REZZO 1-3)

- Indicator of average environmental fixed assets per capita
- Indicator of average environmental non-investment expenditures per capita

In the next analysis process there we concentrate on mentioned indicators that characterize development of environment protection and disparities among monitored micro-regions during years 2002 – 2008.

Indicator of emissions (REZZO 1-3)

Emissions, it means quantity of pollutants emitted into environment air, represent one of serious environment pollution. Within the frame of this indicator there are monitored emissions of Sulphur dioxide (SO_2), Nitrogen oxides (NO_X) and Carbon monoxide (CO). Concrete values in chosen micro-regions belonging to appropriate districts of the regions shows table 2.

Environment pollution, from the view of emissions, is the highest in district Přerov, it means in term of monitored micro-regions it is micro-region Hranicko.

Here, in this district measured values highly overreach average values of the whole region and also values of monitored categories (Sulphur dioxide, Nitrogen oxides and Carbon monoxide) several fold overreach values of other districts or micro-regions. District Přerov is important industrial locality in Olomouc region; it negatively influences all analysed values of emissions. The lowest pollution is noticeable in South Moravian region; but in district Hodonín there are excessive values especially of sulphur dioxide and nitrogen oxides. Low values of emissions are noticeable also in district Tachov, it means in micro-region Lučina. Also micro-region Běleč is not characterized by too high values of sulphur dioxide or nitrogen oxides. But higher pollution, as well as in micro-region Lučina, represents especially carbon monoxide. Nevertheless both micro-regions belong to less polluted areas of Pilsen region.

Tabel 2 Average emissions (REZZO 1-3) in chosen regions and districts in years 2002-2007 (in $kg.km^{-2}$)

Region, district	Sulphur dioxide (SO_2)	Nitrogen oxides (NO_X)	Carbon monoxide (CO)
South Moravia Region	**564.0**	**669.0**	**829.0**
Břeclav	170.0	407.0	559.0
Hodonín	1785.0	829.0	635.0
Pilsen region	**1500.1**	**671.8**	**1297.0**
Klatovy	509.1	265.2	1067.5
Tachov	275.3	155.3	734.6
Olomouc region	**1203.3**	**770.6**	**1273.6**
Přerov	3224.3	2329.5	3308.5

Source: CSO, own calculations

In mentioned cases of environment pollution is possible to say that also business entities must effect on management of environment protection. There are not only certain measures set by government, municipalities etc. Also enterprises formulate in their missions that they make efforts to protect environment; they publish it as their directives or management of environment protection. Enterprises so show their interest in environment protection not only by law-abidingness but also by voluntary definition of own directives of environment protection. Very often it is connected with using of instruments that include also systems of environment management according to standard ISO 140.

Indicator of average environmental fixed assets per capita

Investments in environment protection (environmental fixed assets) are one of important indicators of environment protection. They include expenditures of environmental fixed assets acquisition. Spheres of environment protection are especially control of air pollution and climate, wastewater management and waste management. Other fields of environment protection are landscape and biodiversity protection, protection and decontamination of land, underground and surface waters, limitation of noise and vibration (except workplace protection), protection against radiation, research and development and other activities of environment protection. Following table 3 describes investments in mentioned spheres of environment protection.

Total average environmental fixed assets per capita are the highest in South Moravia Region, likewise in districts Břeclav and Hodonín, it means in micro-region Podluží. These investments overreach also average value of the whole Czech Republic. Micro-region Hranicko in district Přerov approximates to this republic average. But Olomouc region is characterized by lower investments at average. The lowest investments per capita are noted in micro-region Lučina, it means in district Tachov. From these investments the highest amount (63%) is allocated to air pollution control and climate protection and so it is only district, and then also monitored micro-region, where investments in this field overreach. High share of investments in air pollution control is possible to objectively expect in district Přerov in Olomouc region. There are high emissions (see table 2). But two-thirds of investments are focused on wastewater management here.

Similarly also in other micro-regions, let us say in districts, there are investments connected especially with this field of environment protection. Development of environmental fixed assets in monitored period 2002-2008 shows following figure 1.

Tabel 3 Average environmental fixed assets per capita in chosen regions and districts in years 2002-2008

Region, district	Total (in €)	From that (in %)			
		air pollution control and climate protection	wastewater management	waste management	other
Czech Republic	**74.48**	**22.6**	**41.9**	**12.8**	**22.7**
South Moravia region	**96.80**	**19.2**	**56.2**	**12.1**	**12.5**
Břeclav	94.86	29.1	62.6	4.7	3.5
Hodonín	88.96	18.4	44.9	24.8	11.9
Pilsen region	**62.92**	**25.4**	**54.3**	**16.8**	**3.5**
Klatovy	44.62	31.7	47.7	14.0	6.7
Tachov	24.47	63.0	23.0	11.0	3.0
Olomouc region	**53.09**	**25.2**	**56.2**	**10.0**	**8.6**
Přerov	68.89	18.6	66.6	7.8	7.0

Source: CSO, own calculations

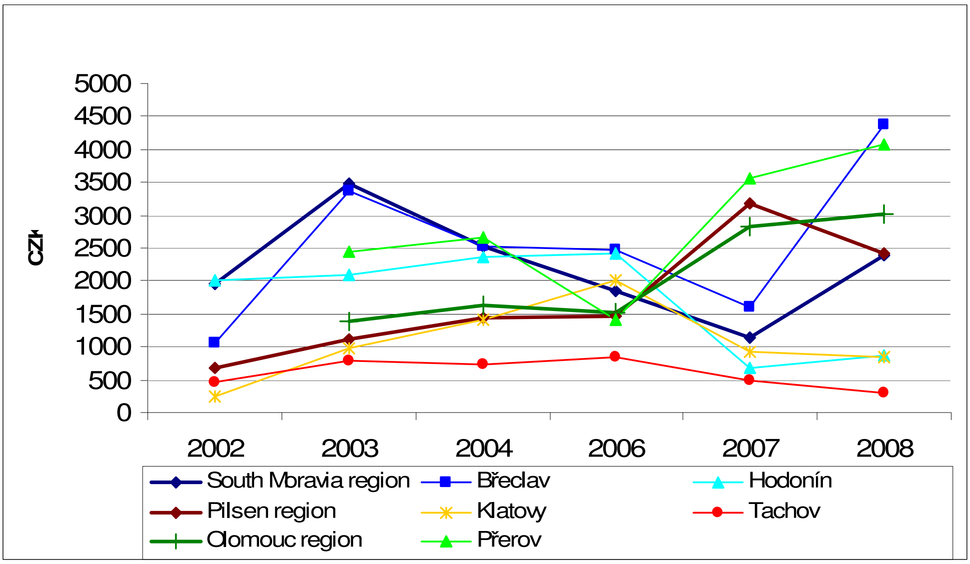

Figure 1 Environmental fixed assets per capita
Source: CSO, own calculations

Indicator of average environmental non-investment expenditures per capita

Environmental non-investment expenditures are important indicator of environment protection too. They include labour costs, rent payments, energy and other material and services payment; main object of services is environment protection. Also these non-investment expenditures are monitored in above mentioned spheres of environment protection. Concrete data are shown in table 4.

In all monitored regions and districts there are average non-investment expenditures per capita lower than average of the Czech Republic. The lowest non-investment expenditures are in Olomouc region (as well as environmental fixed assets); but by contrast district Přerov (where micro-region Hranicko is situated) is characterized by highest environmental non-investment expenditures. These expenditures are higher that environmental fixed assets. South Moravia region and Pilsen region are possible to consider as very balanced as well as districts Břecalv, Klatovy and Tachov.

Compared with variable development of environmental fixed assets non-investment expenditures pre capita increased all the time of monitored period 2003-2008 (see figure 2); this trend is noticed in almost all monitored regions and districts, then also in micro-regions. Again the highest non-investment expenditures are confirmed in district Hodonín, but there decreased these expenditures in last year. Also in district Přerov there non-investment expenditures fell in 2006. Generally it is possible to state higher environmental non-investment expenditures than fixed assets and increasing trend of non-investment expenditures

Table 4 Average environmental non-investment expenditures per capita in chosen regions and districts in years 2003-2008

Region, districts	Total (in €)	From that (in %)			
		air pollution control and climate protection	wastewater management	waste management	other
Czech Republic	**125.04**	**20.0**	**8.0**	**57.0**	**15.0**
South Moravia region	**107.32**	**2.6**	**18.2**	**69.0**	**10.2**
Břeclav	67.84	2.8	29.5	62.0	5.7
Hodonín	87.88	2.5	25.4	57.2	15.0
Pilsen region	**104.92**	**7.6**	**27.8**	**60.5**	**4.1**
Klatovy	61.69	33.4	8.9	55.5	2.3
Tachov	56.65	2.4	8.1	84.5	5.0
Olomouc region	**73.59**	**8.8**	**30.5**	**51.1**	**9.6**
Přerov	100.75	10.3	34.1	34.9	20.7

Source: CSO, own calculations

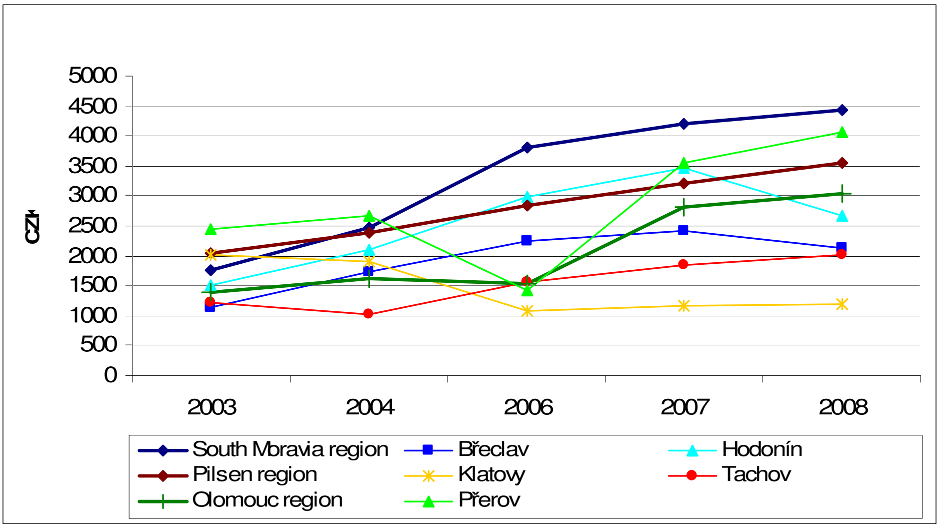

Fig. 2 Environmental non-investment expenditures per capita
Source: CSO, own calculations

Environment protection in municipalities of chosen micro-regions

In municipalities of chosen micro-regions there were also gained data from questionnaire investigation; it enables to complete analysis of environment protection in part. Questionnaire investigation was realized apart with municipalities' mayors and apart with citizens of municipalities belonging to chosen micro-region.

Municipalities of chosen micro-regions contribute to environment protection by quite a few of measures. Ranges of these measures are very broad. It is evident from answers rate of municipalities' mayors and citizens that same measures dominate in all monitored micro-regions. Most often, environment protection is realized in municipalities by waste sorting and collecting, gas services and sewerage, building up of sewerage plant. And it is interesting, in all micro-regions there is also often mentioned care of green (usually as the second most answer).

Micro-regions Běleč and Lučina have certain disparity in comparison with other monitored micro-region.

Another disparity, but very positive, is connected with micro-regions Hranicko, Běleč and Lučina. It probably follows from localization and relates to forests. Some municipalities of these regions mention importance of forest management, it means forest reproduction, forest tending, grubbing of forests attacked by bark beetle etc.

Concrete realized measures of environment protection are possible to see in graphic expression in following figure 3.

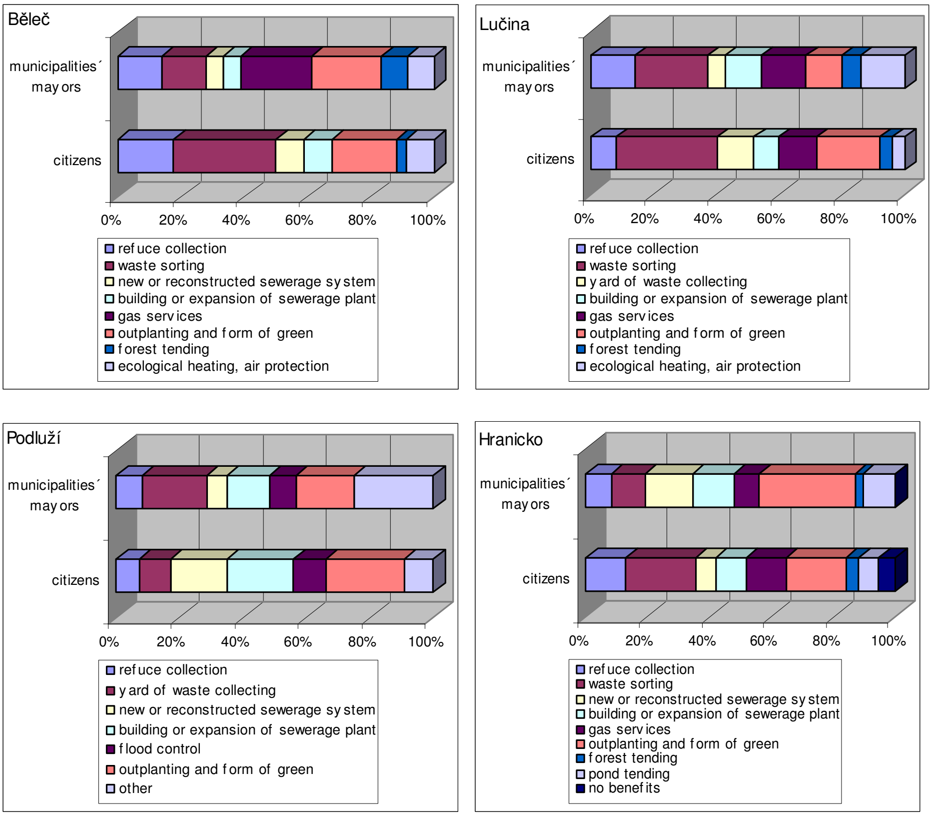

Figure 3 Benefits of micro-region for municipality in sphere of environment protection
Source: own research

5. Conclusion

The paper contributes to analysis of natural resources using especially by evaluation of defined indicators of land use and also complex indicator of ecological stability. In development of individual indicators there are not any essential changes since 2001. But there are specific disparities among municipalities of chosen micro-regions and disparities in data compared with values of region and republic. Possibilities of improvement of situation (or better said possibilities to elimination or lessening of mentioned disparities) are mostly gradual in the case of these indicators (e.g. increase share of grassing (it is % of area permanent grass stands), forestation of agriculturally abandoned lands etc.) Certain possibility is application of agro-environmental measures (e.g. in the field of environment protection and landscape protection, measures in reduction of action of soil erosion, in damming the water in landscape etc.).

Environment is burdened with problems caused human activities and that is why problems are mostly in conflict with natural environment. This question is generally referred to as environmental problems. So it is necessary to solve problems of care, protection and formation of environment. Successful solution of problems connected with this question is possible only with biological, technical, economical and legal knowledge. Also micro-regions and municipalities deal not only with environment protection but also with management of environment protection. But, as shown in the paper, micro-regions and municipalities always have not needed indicators that are suitable to their decision making in connection with necessary environment protection.

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Environmental Engineering and Sustainable Forest Management in the Czech Republic

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Abstract: Economics of forestry is field economics, its object is exploitation of production factors (coefficients), from which the fundamental factor of production is forest. Forest could be defined as well as economical phenomenon or social (public) phenomenon. Forestry strategy of European Union declares that forestry has to be established on three equal columns – ecological, economical, social and cultural in order to ensure functions for sustainable management of society. There is no fully appreciated the significance of forests for rural population and for local growth of services in the social – economic realm. Although, in the historical point of view – agriculture and forestry always have been the elemental attributes of human existence and employment - right in rural space. The paper deals with contemporary economic conception and problems in forestry in the Czech Republic, including forestry and political context, in particular deals on specific aspects and opportunities of forestry economic research.

Keywords: environmental engineering, forest, forestry, sustainable management of forests, forestry economics, national forestry programme

1. Introduction

At the end of 20th century, questions of simultaneous ecological and economical use of natural resources in the principle of sustainable development urgently appeared to forefront. Sustainable development is such economical growth, which reconciles economic and social development with full scope to quality of the natural environment. Among main goals belongs preservation of natural environment to future generations without compromising the ability of future generations to meet their own needs[1].

Forestry strategy of European Union declares that forestry has to be established on three equal columns – ecological, economical, social and cultural in order to ensure functions for sustainable management of society. The goal of ecological functions of forests is preservation and improving of biological diversity, integrity, health and resilience of forest ecosystems, with taking into account the possible scenario of global and landscape changes. Strategic goal of economic functions of forests is long-term improving of forestry competitiveness and increased using of forestry products, goods and services in life of society. Strategic goal of social functions of forests is preservation and improving of social and cultural attributes of forests and forestry (cultural heritage and landscape,

[1] Definition of sustainable development was determined in 1987 in so called „Brundtland report" in World Commission on Environment and Development - WCED.

quality of life, recreational functions etc.)

Conclusions of international summits, as well as national documents (e.g. national forestry programme) confirms increasing significance of economical understanding of sustainable forest management and escalating importance of forests to society. However, simultaneously postulate questions of financial sources and requirement of solution.

2. Materials and methods

Economics of forestry is field economics, its object is exploitation of production factors (coefficients), from which the fundamental factor of production is forest. Forest in the meaning of legal doctrine is understood as forest stands with their environment and land associated with the forest functions[2]. Forest could be defined as well as economical phenomenon or social (public) phenomenon.

Forest as economical phenomenon is object of appropriating, in the process the principal long-term target of forest ownership and management is regulation of growing processes of forest species, removing the forest production and social - economic aspects of exploitation this yield. The forest behaves as object of national economy.

Forest as social phenomenon is object demanded by human society, which is modeled by social demand, particularly on non-production function of forests. The forest mostly behaves in that meaning as component of environment (Kupčák, 2006)

4th. ministerial conference on the protection of forests in Europe (Vienna 2003) accepted resolution *V2 Enhancing economic viability of sustainable forest management in Europe*, from which is clear, that:

- economic viability is key pillar of sustainable management of forests and has significant importance for preservation of forests and their multiple benefits for society,
- sustainable forest management in Europe relies on millions of private owners, forest-related enterprises, public bodies as well as on a highly qualified workforce,
- forests provide raw material, goods and services for arange of sectors and are a basis for income and employment (Anonymus, 2003).

Introduced approaches to the forest are branch of knowledge of human activity – forestry, in the process fundamental philosophy of contemporary forestry and economic forest using – forest production should follow the principle of sustainable forest management. At provision of self-sufficiency!

The sustained-yield principle in the conditions of the Czech Republic is not lately attribute. With notice that already in the epoch of reign Charles IV. (1316 – 1378), Bohemian king and emperor of Holy Roman Empire, was stated in the code of law „*Majestas Carolina*“ (1351): „Forest, nation wealth preserve, non-maculated have

[2] See Law No. 289/1995 Coll., on Forests and Amendments to some Laws (the Forest Law).

eternal and be endeavour guard of their essence." So-called. „constant forest management" was scientifically formulated by Hartig[3] (1764-1837), in which meaning is based on principle of sustained yield and principle of balanced revenue growth. In the Czech forestry is for a long time known classical model so-called normal forest. The foundations of normal forest theory originate from Hundeshagen (1826), according to him is forest in normal state, if is continually managed, it means that periodically provides benefit (wood volume from normal harvesting). Nowadays – by normal forest is labeled forest, which would provide in the optimal state constatly balanced revenue growth (Simon, 1994, cited by Kupčák, 2006).

Normal forest model is established on precondition, that each age group occupies equal surface, then is valid:

$$f = \frac{F}{u} \quad (1)$$

where
F = total forest land area,
u = rotation period in years.

Area of main felling (F_{en}) is in the horizon of planning period (n) set out by relation

$$F_{en} = n \cdot \frac{F}{u} \quad (2)$$

In case, when in it the stands would be not carried out intermediate felling (thinning), timber volume at the stand in felling age – mature stands (m_u) will be increment summation (Z_i), then

$$m_u = Z_1 + Z_2 + ... + Z_{u-1} + Z_u = \sum_{i=1}^{u} Z_i \quad (3)$$

However, the timber volume at the stand in felling age m_u is only part of total production, another production part is timber from intermediate felling, the total volume of logging in the rotation period is determinated by total mean increment (PCP), when

$$PCP = \frac{m_u + \sum_{i=1}^{u} N_i}{u} \quad (4)$$

where N_i = timber from intermediate felling.

Consequently, normal cut (H_i) comes out from relation

$$H_i = u \cdot PCP = m_u + \sum_{i=1}^{u} N_i \quad (5)$$

Normal forest model facilitates complex formulation of dependence among mensurational quantities (age class proportion, increment, timber volume at the base), logging potential and forest production. It is possible to apply on providing sustained forest production and could be the foundation when forest management plan is assembled, forest production planning and analysis of forest property profitability.

[3] Hartig Georg Ludwig (1764-1837) – German forester, well-known by concept of forest stand tending and forest regeneration – founder of small-scale regeneration under shelterwood; on segment of forest management planning - principle of permanence, balance and sustained wood harvesting; concerned himself with forest stand classification and method of rotation period scheduling.

Table 1 Total fellings

Fellings	Unit	1985	1990	1995	2000	2005	2006	2007	2008
conifers	mill. m^3	12,82	12,17	11,31	12,85	13,88	16,12	17,28	14,88
broadleaves	mill. m^3	1,09	1,16	1,06	1,59	1,63	1,56	1,23	1,31
total	mill. m^3	13,91	13,33	12,37	14,44	15,51	17,68	18,51	16,19
Felling (intensity)	m^3 per hectare	5,29	5,07	4,70	5,48	5,86	6,67	6,98	6,10

3. Results

Present state of forestry in the Czech Republic comes out from forest land area 2 649 thousand hectares, which corresponds with forest cover percentage 33,5 %. In tree species composition prevail conifers – 75,1 % (from that spruce 53 %, pine 17 %); broadleaves amount 23,9 % (from that oak 6,6 %, beech – 6,7 %). According to character of using, so-called forest categorization amount commercial forests – 75,8 %, protective forests – 2,8 %, special purpose forests - 21,4 %.

Total growing stock volume is approximately 668 million m^3, average level fluctuates about 250 m^3 per hectare. Total mean annual increment exceeds 17 million m^3 per year, which match 6,7 m^3 per 1 hectare of forest land area per year.

Total annual fellings exceeds 15 milllion m^3 per year, which match 5,9 m^3 per 1 hectare of forest land (felling intensity). Proportion of conifers in total fellings is around 90 % (from that spruce cca 75 %). Trend in total fellings for last twenty years shows table 1 - Source: Ministry of Agriculture (Anonymus, 2009).

In timber assortments prevails roundwood (more than 8 mill. m^3) and pulpwood (around 4,5 mill. m^3). Other wood supplies compose other industrial wood including wood chips and firewood.

National Forest Programme

National Forestry Programmes are considered as concepts for enforcing of permanent sustainable forest management in relation to the long-term improvement competitiveness ability of the forest management. National Forest Programmes are governmental documents and part of a national forestry policy, and at the same time it is in them completed the EU Forestry Strategy.

In the year 2008 was by resolution of the Government of the Czech Republic adopted The National Forest Programme of the Czech Republic for the period until 2013 (NFP). Already in the introduction it is here quoted a motto: *"Strong economic performance must go hand in hand with sustainable use of natural resources"* (see the Guiding principles for the Common Agricultural policy, market and rural development policies. The European Council, Goteborg, 2001) (Anonymus, 2007-2013).

The targeting of NFP suggests and also underlines its basic structure, which consists of four parts or objectives-pillars. These are based on groups of forest functions:

- Economic functions - the strategic objectives are a long-term improvement of the competitiveness of the forest sector and the increased use of forestry products, goods and services in the life of society,

- Ecological functions - strategic objectives are the preservation and improvement of biological diversity; integrity, health and resilience of forest ecosystems on a local scale with a view to a possible scenario of global and landscape changes,
- Social functions – strategic objective is to contribute to the quality of life through conservation and improvement of social and cultural dimensions of forests and forestry.

Content structuring of NFP determine:

- Improving long-term competitiveness - the pillar of economic;
- Protection of the environment - the ecological pillar;
- Improving the quality of life - the social pillar;
- Strengthening of coordination and communication - the communication pillar.

From the mentioned structure of NFP explicitly results its significant socio-economic nature and function.

4. Discussion

Forest production, when is expected, that forest will fulfill perspective of multifunctional utilization, is often discussed topic recently, topic of social-economic character. At the same time, fulfilment of all claims and requirements laid on forests by society is still and unambiguously reliant on profit creation from timber sale.

Proportion of forestry on gross domestic product comes out from natural conditions and state industrial potential. The main cause of contemporary relatively low portion of contributions to national economy consists in so far unsolved problems of economic conception of non-wood-productive functions of forest, which in fact forestry is financing – it means functions are part of economic environment, but only on side of expenditures. Concurrently with significance of mentioned forest functions also increases economic importance of forestry as provider of ecologic raw material from renewable natural source – wood, as for processing industry (particularly wood-processing and pulpmill), as well as from perspective of energy source. In this respect approach also questions of extent wood utilization to discussion problems, as well levels of added value when wood is processed inland.

According to Bluďovský (2003), raw timber export from the Czech Republic amounts about 3 mill. m^3 per year, lumber export cca 1,5 mill. m^3 and wood-pulp export around 250 thousand tuns (converted - volume of exported lumber approximately correspond to 2,7 mill. m^3 of raw timber and exported wood-pulp, 1,3 mill. m^3 of raw timber). In spite of certain simplification could be stated that nowadays is from CZ exported in raw (not processed) state and in relatively little worked wood products and paper-making half-finished products around half of annual production of raw timber (Bluďovský, 2003).

Statistical survey and annual reports, published by Ministry of Agriculture of the Czech Republic are sources of strongly aggregated national data on forestry (simultaneously however the only official source), which could hovewer significantly distinguish regionally (ignoring statistical data influence, impacted as well by respondent selection) (Anonymus, 2009). In the long term in forestry is a lack of systematic data analysis, known in agriculture – for example data network „Farm Accountancy Data Network“ (FADN [4]).

5. Conclusion

One of the basic conditions of the forestry management, in the same way the prerequisite existence condition of forestry and forest management is precondition of balanced management, like that forest owner is able to cover the expenditures from the revenues. Economic base are takings from realised timber production compared to silvicultural operations expenditures (specific economic category in forestry), and consequent amount of balance – economic result. Present-day Czech forestry gets on the problematic crossroadse in that meaning. How and to what degree are asserted objective impacts and to what degree it is dealt with results of “management“ (including supranational impacts) is core of the matter and subject of additional needed investigation.

Contrary to mentioned deduction however stands the disposition, structure and perspectives of renewable sources using (as one of the preconditions of sustainable development strategy), including adopted conceptual strategic materials or developing programs (not only in the sphere of forestry management, but also agriculture, landscape management, components of natural environment, rural development).

Fundamental World and European forums (e.g.. Rio de Janeiro 1992, Helsinky 1993, Montreal 1993, Lisabon 1998, Johannesburg 2002, Vienna 2003 etc.) present three blocs of forest functions, namely ecological, economic and social, amongst them meaningly (value) without distinguish, it means there are in broader sence equivalent. The emphasis is laid on parallel sustaiable providing of all three functions, it means that production and providing of functions should be maintainable as well as ecologically, as economically, as socially, which is in harmony with world concept of sustainable development (Šišák et al, 2005)

The aim of the paper was give notice to existence and acceleration of real economic aspects of Czech forestry, with eduction of suggestion for further research - not only in scope of forestry economic research. Besides research also for taking into consideration in practical activities – for example legislation.

[4] FADN – data collection system, which is used as basic information source of comparable information on economic results and economic situation of agricultural companies in member states of EU (in the Czech Republic the survey was set up in 1995; in 2004 was in FADN CZ included more than 1 600 agricultural companies.

To the conclusion one comment, that already third ministerial conference on the protection of forests in Europe (Lisabon 1998) in the resolution L1, part II (Future actions) stated, that signatory countries engage further research efforts on the socio-economic aspects of sustainable forest management, in particular on the assessment and valuation of the full range of forest goods and services, in order to provide reliable information for policy and decision making and public dialogue.

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The Illegal Dumping of Waste in Forest Areas - Evidence from Rural Territory

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Abstract: Household waste generated is often uncolleted in rural areas causing various types of pollution like: air and water pollution, soil pollution and the aesthetic degradation of the landscape. The environmental legislation proposed by the European Union was transposed on the national legislation but the implementation process was difficult because of particular situations encountered in practice. Rudimentary infrastructure of waste management and limited access to waste collection services lead to uncontrolled household waste disposal. In this context, the geographical location of rural settlements influences the way of waste disposal either on river banks or open dumps placed on roadsides or forest areas with various environmental implications. Those, forest areas in the proximity of human settlements or recreation areas become vulnerable to waste pollution. Even if local authorities are obliged to provide waste collection facilities since July 16, 2009 the illegal dumping of waste in forests is still present. This situation is reflected by field observations from Suceava and Neamț counties. Usually forest areas affected by uncontrolled waste disposal are located in hilly regions or subcarpathian areas. The degradation of these areas is visible and this can have a negative influence not only on the environment but also on tourism activities.

Keywords: waste management, forest areas, uncontrolled waste disposal

1. Introduction

Increasing the amount of waste is no longer a novelty, but waste management should be a priority for any local authority. We are aware that we live in a society where the consumption of products is enormous, and it inevitably leads to an increasing number of "useless materials" which can be recovered by developing waste management sector.

Factors that may influence the amount of waste generated are multiple, for example, income of the population in developed countries could enable a higher consumption of products reflecting the high share of recyclables in household waste composition. Also, the large number of population in some low-income countries, would lead inevitably to an increasing amounts of biodegradable waste generated.

Leaving aside the social inequities a particularly importance in waste generation and their treatment play the consumer behavior and the emergence of new packaged products on the market. Thus, educating citizens in environmental spirit is essential and must take into account the practice of waste prevention and recycling.

Waste management issues can be seen in the improper waste disposal facilities. Dumping waste outside special sites generate serious environmental problems.

A simple landfill site that does not meet environmental standards may adversely affect soil quality, can contaminate groundwater, can pollute air and damage the local landscape.

This research aims to exhibit the situation of local waste management and its environmental influences in Romanian rural areas.

2. Materials and methods

The study area is geographically located in north-eastern Romania and administratively situated of the North-East Development Region.

First, this paper analysis the dysfunctions of current waste management systems from rural areas, which encouraging the illegal dumping on forest areas related to the field observations from 2009-2011.

A comparative analysis is done regarding the access of rural population to sanitation services using local waste statistics provided by Environmental Protection Agencies, for the period 2003-2008 (latest available data).

Secondly, this paper examines the implementation as a new EU member of EU waste management regulations on rural areas and its implications at the local level.

3. Results

Processing the statistical data we met two different situations.

On the one hand, rural population access to sanitation services from Neamț County has remained constant over the past 10 years, so that in 2008 only 10% of the population benefits of waste collection services (Fig. 1).

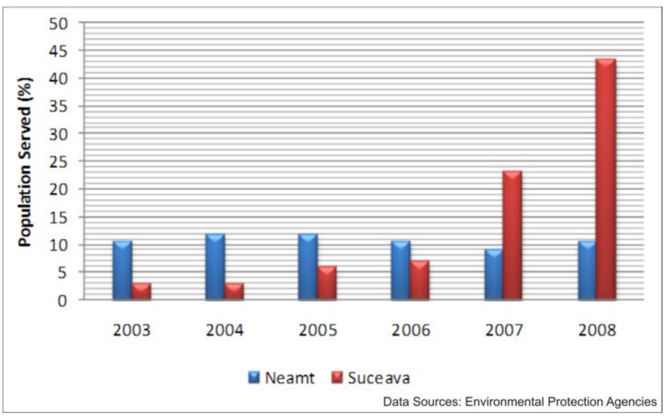

Figure 1 Rural population served by sanitation services

On the other hand, in Suceava County statistics show that over 40% of the rural population have access to sanitation services in 2008, compared to only 3% in 2003 (Fig. 1).

Fields observations from 2009 confirm that in rural areas of Neamț County sanitation services are lacking or inadequately performed. Thus, we noticed that the forests around rural areas have become real dumps. It seems that the most affected are hills and plateau regions, where geographical conditions favor the bad practices of the inhabitants.

Forest areas around rural communities: Brusturi, Oglinzi, Făurei or tourist resting places are affected by these inappropriate dumpsites (Fig. 2).

Open dumps are not missing in Suceava County, because the authorities do not take necessary measures to stop the illegal dumping of waste.

In the Carpathian areas, near settlements Râşca, Boroaia, Mălini, one can see forest areas affected by visible aesthetic degradation. Because of proximity to rural settlements, the rivers and tributary streams from mountain region are more vulnerable to waste pollution. Most of the waste generated and uncollected is partially recovered in households, and remaining waste is disposed in open dumps (Apostol and Mihai, 2011).

Figure 2 Waste dumping in forest areas - field observations

4. Discussion

New EU members are facing with illegal dumping of waste on rural territory and they have difficulties to accomplish the EU waste management regulations (Apostol and Mihai, 2011; Orosz and Fakezaz, 2008; Kulczycka and Zygmunt, 2008).

European Union forced the construction of sanitary landfills, according to environmental standards and at the same time the closure of old dumps from urban and rural territory in order to minimize the environmental pollution and to rehabilitate the degraded sites.

The implementation of European standards has occurred according to local particularities of each Member State (Mazzanti and Zoboli, 2011; Pires et al., 2011).

In Romania, building new landfills was not completed until the date set for the closure of non-compliant dumpsites. This fact has generated an unpleasant situation in which the costs of sanitation services have increased because the waste had to be transported to the nearest newly built landfill.

The most affected are rural areas where some local authorities have abandoned sanitation services for financial reasons. Moreover, due to lack of environmental education of local population, in many areas appeared household waste dumped on river banks, on roadsides or forest areas. The dumping of waste in inappropriate places have created a desolate landscape and affected tourist areas.

As we have seen in the analysis of statistical data and field observations, the reality existing in Romanian rural areas is one that exceeds the measures taken by local authorities. Although waste management infrastructure is still rudimentary in many rural communities, by 2009 it was able to cover the needs of residents.

Current high price of transport and waste disposal causes problems which are beyond the control of local authorities. Acquis implementation is difficult to achieve in rural areas because of the absence of a coherent waste management policy related to natural and socio-economic conditions. Fines for illegal dumping of waste in inappropriate places are required by low but the rural authorities sometimes avoid to apply them because it is difficult for they to identify the people who are responsible for these bad practices.

Ichinose and Yamamoto (2011) show that the number of illegal dumping incidents decreases as the number of intermediate waste management facilities increases.

Development of environmental polices requires the involvement of public authorities and in the same time the support of civil society. People must be aware to their environmental issues and to contribute for a local sustainable development. Management plans of waste and recycling should be developed in order to sustain environmental, economic, and social development principles (Demirbas, 2011).

5. Conclusion

The implementation of EU regulations on waste management in Romanian rural space is still difficult and the improper sanitation services lead to various environmental issues.

Low economic support, incompetence and lack of interest shown by local authorities and sometimes the lack of ecological education among citizens contribute to aesthetic degradation of forest areas in proximity of human settlements.

Development of proper waste management facilities and extension of sanitation services in rural areas should be the priority for environmental investments.

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Current status and prospects of the market with energy woodchips in the Czech Republic

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Abstract: The article is a partial contribution to the broad economic issues of renewable natural resources in the Czech Republic. Using publicly available information sources and databases, it describes and analyses the current state of the market for forest woodchips for the period from 2005 to 2009 in terms of the balance of consumed volumes, available quantity and proportion in achieving a partial indicative target of 8.0% of the share of renewable energy sources in gross domestic energy consumption till 2010. It discusses the bases for a potential increase in the share of forest woodchips in the energy mix of renewable energy sources in the Czech Republic and further development of the market for energy woodchips.

Keywords: energy woodchips, woodchips market, renewable energy

1. Introduction

Energy requirements for life and continual meeting of the needs accompany the entire existence of the mankind, and it is biomass, dendromass in particular, that has represented one of the major source for the millennia. It is obvious that economic development is conditioned by the need for energy, not only electrical but also thermal. This has resulted in increasing demands for fuel and energy sources and, in accordance with accepted economic theory, also the increase of their prices.

The preferred sources of the present time and in the future include renewable energy sources (hereinafter referred to as "RES"). One of the most important RES in the energy mix is biomass **-** the biodegradable fraction of products, waste and residues from agriculture, forestry and related industries. Historically as well as currently, the most commonly used types of biomass include wood and wood waste. In the Czech Republic, biomass takes, apart from the energy from hydro and photovoltaic power stations, the position of the main renewable source. The issues of obtaining energy from RES, especially from dendromass, are discussed at many levels and are one of the widely discussed topics in the whole forestry-wood sector.

The objective of the paper is to assess the current state of the market with energy woodchips in the Czech Republic using publicly available comprehensive information from state statistics (the Czech Statistical Office), departmental statistics (the Ministry of Industry and Trade of the Czech

Republic and the Energy Regulatory Office of the Czech Republic), our own inquiries and surveys. Another objective is, using the results of an analysis of the potential and resulting quantification of utilisable dendromass, to outline the further potential development of the market with energy woodchips in the Czech Republic and the potential share of dendromass in the total fuel mix of RES to achieve the overall national target of 13% of the RES share in the final gross energy consumption in 2020 shown in Annex 1 Directive of the European Parliament and Council 2009/28/EC.

2. Material and Methods

The ways of encouraging electricity production from RES in the Czech Republic has been regulated by Act 180/2005 Coll. (an act on the promotion of renewable energy sources) that was approved based on the implementation of the Directive of the European Parliament and Council 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market. This directive also set indicative targets of electricity production using RES for the individual Member States. The Czech Republic after the accession was assigned the target of 8.0% of domestic gross electricity consumption by 2010. The existing support system for electricity production from RES is based on manufacturers' options to choose from two variants of support:

- mandatory purchase for purchase prices (PP) set by the Czech Energy Regulatory Office
- green bonuses (GB).

The basic principles of mandatory purchase and purchase prices are as follows:

- guaranteed simple payback period of up to 15 years,
- guaranteed price throughout the economic life of the source,
- regarding newly installed production facilities, the purchase prices can be reduced by up to 5.0 % over a previous year,
- the compulsory purchase cannot be applied to co-firing of RES and fossil fuels.

The basic principles of the green bonus are as follows:

- the subject of the support is the entire electricity production minus own consumption of the resources,
- the price of the green bonus is set by the Czech Energy Regulatory Office for the period of a calendar year during which it remains unchanged,
- the benefit of support in the form of the green bonus, as compared to the mandatory purchase, lies in the fact that the producer receives the market price for electricity plus a green bonus (generally, it is a higher value than the purchase price in case of the mandatory purchase).

The current legislation does not deal with the support for heat production using RES and the support for high-efficiency cogeneration of electricity and heat using RES. The determination of the individual types, methods of use and parameters of biomass in supporting electricity production using RES is dealt with Decree 482/2005 Coll. that has been updated by Decree 5/2007 Coll. Energy dendromass is described here as a residual matter from logging, thinning, pruning (created in forest), material from greenery maintenance (trails, streams) and biofuels produced from this residual mass (chips, firewood, etc.), including incidental and residual the products from their processing. This type of biomass is used for electricity generation by **high-temperature gasification (HTG), co-firing (F2) or parallel firing (P2) with fossil fuels and direct firing of single biomass (O2)**, while the production by direct firing process has always more financial support than the process of parallel firing or co-firing.

The Energy Regulatory Office of the Czech Republic (hereinafter referred to as "ERO") sets the support for individual methods of generating electricity using RES for each calendar year in the form of a pricing decision, differentiated by the categories of biomass.

The basic methodological approach is the analysis and extrapolation of time series of support types of electricity generation using the biomass of the Q2, F2 and P2 category, and the comparison of the values found out with the values of dendromass supplies – forest woodchips to generate electricity. This applies to the period of 2005 - 2009. The data of woodchip supplies for 2010 are not available yet.

3. Results

The total share of electricity generation in the gross domestic consumption in the Czech Republic was **8.30%** as of 31 December 2010, and biomass took **26.04%** of the renewable sources in total between 2005 and 2010. In the RES energy mix, biomass ranks second behind water power plants with installed capacity above 10.0 MW.

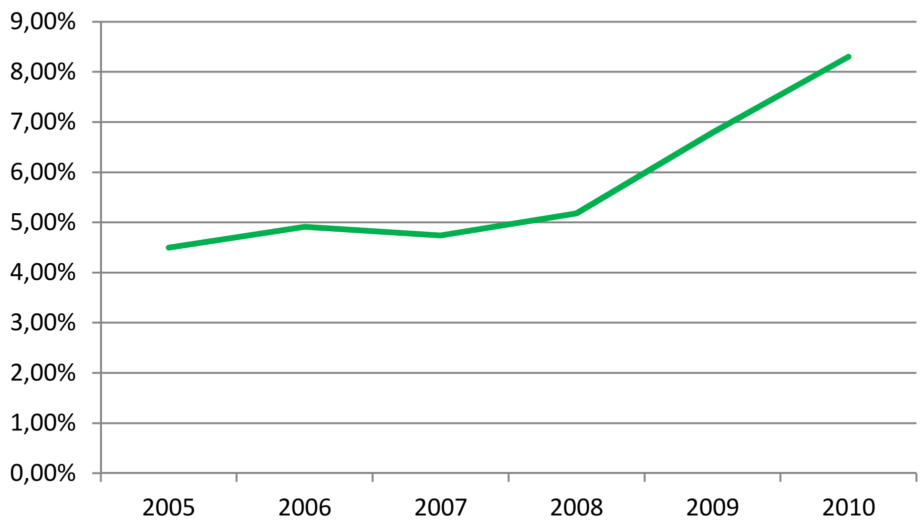

Figure 1 The development of the share of RES in the domestic gross electricity consumption in the Czech Republic

However, the share of forest woodchips in the gross electricity generation between 2005 and 2009 was only **0.49%**. The main reasons for this low share could be seen a low number of installed facilities for electricity generation from forest woodchips, the predominant way of generating electricity by co-firing forest woodchips together with non-renewable resources (F2), and a low differentiation of the market with forest woodchips as a result of the prevailing handling with the source (dendromass) by the state-owned enterprise Lesy České Republiky, s.p., which manages 50.65% of wooded land in the Czech Republic, [Zelená zpráva, 2009]. One of the major purchasers of forest woodchips in the Czech Republic is the electricity company ČEZ, which generates electricity from RES by the co-firing process.

Table 1 The share of forest woodchips in the gross electricity generation in the Czech Republic

	2004	2005	2006	2007	2008	2009
in MWh	272,948.5	222,497.2	272,724.5	427,531.2	603,047.9	650,060.6
in %	0.33	0.27	0.32	0.48	0.72	0.79

Source: MIT (the Ministry of Industry and Trade of the Czech Republic)

Table 2 The number of registered facilities for generating electricity and heat from forest woodchips

type/period	2005	2006	2007	2008	2009
electricity generation	27	23	18	21	23
heat production	669	708	948	699	812

Source: MIT

Table 3 The balance of consumption and foreign trade with forest woodchips in the Czech Republic

Consumption type	2005	2006	2007	2008	2009
for electricity generation (t)	199,436.6	250,150.2	402,986.7	579,384.1	664,955.1
for heat generation (t)	851,560.2	88, 456.7	934,669.3	1,023,815.9	948,261.4
foreign trade balance (t)	-16,389.0	86,204.0	135,771.0	228,546.0	167,550.0
export (t)	43,327.0	112,652.0	173,852.0	255,255.0	219,221.0
import (t)	59,716.0	26,448.0	38,081.0	26,709.0	51,671.0

Source: MIT

The overall balance of the consumption of forest woodchips used in the generation of electricity and heat between 2005 and 2009 was within the range of 1,034,607 – 1,780,766.5 tons of dry matter (note: at 0% relative humidity). Recalculated to 1.0 m^3 with coefficient 9.0 m^3 = 1 ton (dry matter), it is 1,965,753 - 3,383,456 m^3.

The conclusions of the analysis and the resulting quantification of utilisable forest biomass emphasizing logging residues for energy purposes, taking into account the risks arising from the impact on soil, nutrient cycling and biodiversity [Ústav pro hospodářskou úpravu lesů, 2009], show that, taking into account the constraints arising from forestry legislation, forest dendromass from main felling in the quantity of 812,456 m^3/year is available for energy generation. When adding an ecosystem-based perspective based on sets of forest types and target management, the available amount is reduced to 612,866 m^3/year. Another limitation resulting from the analysis of risks and the requirements of environment conservation bodies based on documents from cooperating organizations also reduces the quantity available to 503,819 m^3. These conclusions show that annual available quantities of logging residues from forest felling from main felling do correspond with the total annual amount need of forest woodchips consumed to generate electricity and heat according to data from the Ministry of Industry and Trade. Although the difference between the maximum annual available quantity and the average annual consumption of forest woodchips represents a shortage of approximately 562 thousand m^3, however, since 2006 approximately 155.5 thousand m^3 of forest woodchips was exported annually.

Table 4 The development of purchase prices of forest woodchips in the Czech Republic

Price	2005	2006	2007	2008	2009
€/m^3	9.25	16.11	23.37	23.12	Data unavailable

Source: CSO, e-2201-11 Lesnictví a myslivost

Table 5 The development of purchase prices (PP) and green bonuses (GB) for electricity generation using biomass in € / MWh

period	2005		2006		2007		2008		2009
Biomass category (Decree 482/2005 Coll.)	PP	GB	PP	GB	PP	GB	PP	GB	PP
O2 current	-	-	-	-	-	-	-	-	80,28
O2 prior 1 Jan ’08	87.17	54.65	102.11	62.54	105.85	59.76	125.61	63.81	120.60
O2 after 1 Jan ’08	-	-	-	-	117.73	71.64	138.85	77.05	133.04
F2	-	28.50	-	27.91	-	28.44	-	27.69	-
P2	-	36.88	-	36.92	-	37.80	-	38.52	-

Source: Pricing decisions of ERO nos. 10/2005; 8/2006; 7/2007; 8/2008; 4/2009

Given the approximate average calorific value of forest woodchips of 9,000 MJ/m^3, the *energy efficiency of 1 m^3 of wood chips at a* relative humidity of 25.0 to 30.0% is **2.5 MWh.** If we compare the development of green bonuses for the most frequent biomass category F2 (co-firing) with the purchase price of forest woodchips in 2007 and 2008, it is apparent that this form of support is approximately three times as much as the purchase price of forest wood chips. The support for electricity generation in the F2 category, neither in the P2 category, therefore does not make much room for increasing the supply because the purchase price of forest woodchips is based on the EXW parity and subsequent generation of electrical power requires additional costs: freight, handling, firing, electrical power distribution.

4. Conclusion

The results of comparing the overall balance of consumption and foreign trade with forest woodchips with the maximum annual available quantity, only taking into account the limitations arising from forestry legislation, raise two fundamental questions.

a) Is it possible to further increase the share of forest woodchips in the gross electricity generation in the Czech Republic?
b) Is it possible to further develop the market with forest woodchips in the Czech Republic?

The space for the answers to these questions can be found in considering the changes in the use of some types of raw wood used technologically so far. Given the pricing situation of weak deciduous trees, especially oak trees, which has been so far used in the pulp and paper industry and for which demand is steadily declining, this can be considered as another, although also limited, source of renewable energy.

Biomass is considered by the valid National Energy Policy (NEP) to be a decisive – a dominant type of RES. The facts outlined above, however, show that dendromass is a minority type within a large group of biomass and it in a persistent state. Its further development is hindered by various barriers; one of the most important ones is the absence of consistent mapping of potential statistical records within the competence of a single department. Finally, the following issues are very important: production economy, use of individual RES sources, finding effective ways of supporting RES to ensure their development while effectively spending the funds used for direct or indirect support. One possible way is to promote combined generation of electricity and heat (CGEH) as one of the highly efficient and also environmentally acceptable means of energy generation while, as compared with separate generation of electricity and heat, saving the energy from primary fuels. The CGEH is closely linked with the reduction of CO_2 emissions, which generally has a positive impact on environmental quality. The CGEH is supported in many countries of the European Union and further development of the CGEH is anticipated, among other things, in the action plans in connection with the climate-energy package approved by the EU.

Finding effective ways to support and use individual renewable resources is a task for the newly-prepared Action Plan for Biomass in the Czech Republic, whose preparation is enshrined in the Government Bill 369/2011 of act on supported energy sources and on amending certain laws.

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State of the art regarding the ecological and economical assessment of forest sites

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Abstract: The evolution of site assessment highlights some tenets of forest site productivity like the height – age site index, Eichhorn's rule or using some soil idicators such as soil calcium and magnezium, nitrogen, soil moisture, soil texture, availability of base cations, and other soil resources. The article establishes which of these tenets have a real influence regarding economical and ecological assessment of forest sites. The research done in the dacades of the last century have demonstrated a good corelation between height growth and stand volume growth, so that the total volume production of a certain tree species at a certain stand height should be similar for the all site classes and so the stand volume growth is independent for a variety of thinning grades. Field experiments and using of the yield level theory in order to assess site productivity has eased the development of a three-dimensional model of the relationship between some biometrical indicators such as stem number, quadratic mean diameter and stand basal area. At the last, the economical assessment of forest sites in the late XX centuries mean a quantification of the all forests functions such as recreational, health hygienic, edaphic protection, water management forest function. In this review of assessment of forest sites there is a case study located in Dragomirna Plateau (Suceava County, Romania) about how to evaluate forest site productivity according to some soils proprieties.

Keywords: forest site, assessment, stand heigh, soil properties, Dragomirna Plateau

1. Introduction

In the context of anthropogenic and climatic changes in Romania today, is a phenomenon found quite evident: forest vegetation is no longer a reliable indicator of the potential for the forest sites in an area remained occupied by forest. Contributing to this state of affairs derives from the significant changes it has undergone in recent centuries Romanian forest by restricting the area occupied by forest (from approximative 70-80% at 300-400 years ago, to 27% today), by changing natural composition of many stands in the country and massive extraction from the forest of valuable species and inadequate promotion of them, and not least by the climate changes affecting Earth, especially in the last five decades.

An understanding of what a given forest site can offer, through all climatic and edaphic conditions, is certaintly the key to a modern forestry, based on the precepts of sustainable development of forests.

As a definition, forest site productivity is the production that can be realized at a certain site with a specified management regime. Classification of some methods for assessing forest site productivity take into account of several factors such as soil propreties, climate, plant community characteristics and site index by stand height.

Table 1 Classification of some methods for assessing forest site productivity (Skovsgaard and Vanclay, 2008)

View	**Geo-centric**	**Intermediate**	**Phyto-centric**	**Dendrocentric**
Direct	Soil texture Volume measurement Soil moisture and nutrient analysis Photosynthetically active radiation			Volume measurement
Intermediate	Soil parent material	Rooting depth Humus form	Ground vegetation	
Indirect	Climate Physiography Geographical coordinates		Plant community characteristics	Site index by stand height

Biometrical methods of forests sites assessments use of the yield level theory for estimating site productivity has facilitated the development of a three-dimensional model of the relationship between stem number, quadratic mean diameter and stand basal area. Given this model, a stand density index based on the combination of stem number and quadratic mean diameter provides an indication of the yield level, which may be used to adjust height-age based estimates of site productivity (Skovsgaard and Vanclay, 2008).

If in Romania to assess the forest site is a diagnostics and quantification of the main factors, in the U.S., France and other European countries how to assess the potential of forest stations is more "pragmatic" in the sense that the evaluation is limited to measurement of biometric stands characteristics.

Therefore, quantification is based on stationary dendrometric data accumulation, carried out on representative population of tree species, on values such as average annual growth, dominant height and other. Research efforts in this area were conducted in two directions:

- on the one hand to try a better correlation between different environmental factors and main characteristics of tree growth;
- on the other hand sought to develop a methodology for determining the types of forest sites based on aspects of differentiation of forest vegetation and the abiotic environmental characteristics differentiate (Becker et al., 1980).

In terms of economic evaluation there are a number of attempts to determine the economic efficiency of the group of forest site. But studies are somewhat difficult to perform because of actual methods. Further, I will give a range of assessment methods and their ease of application (figure 2).

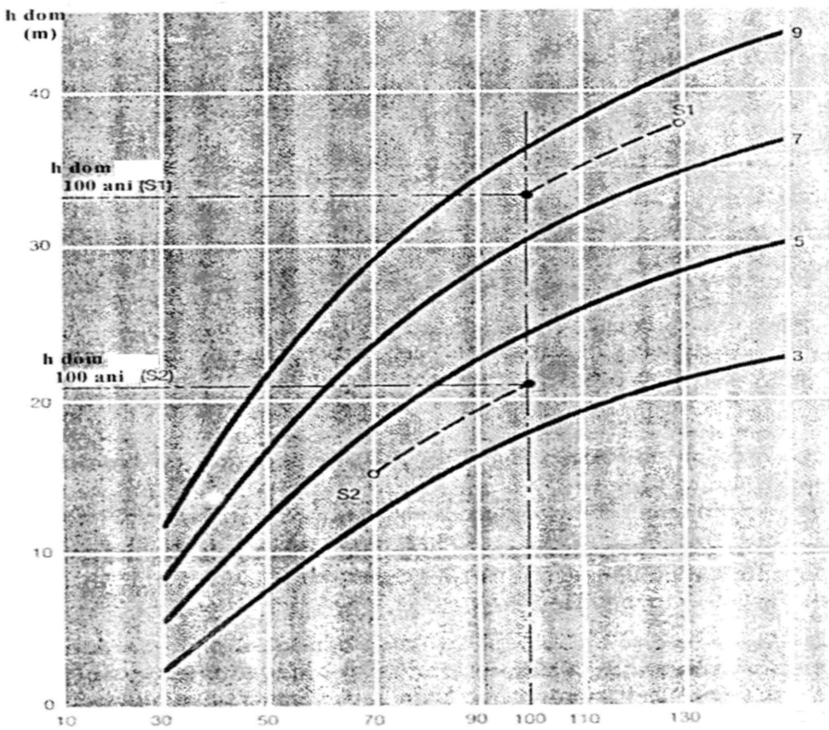

Figure 1 The growth of dominant height of beech in North-Eastern France for four yield classes (3, 5, 7 and 9 $m^3yr^{-1}ha^{-1}$ at 100 years) (Becker et al. 1980)

Table 2 Correspondence between ecosystem benefits, appropriate evaluation methods and transferability of results (Shuang *et al.*, 2010).

Type of ecosystem benefits	Ease of assessment	Method of assessment	Transferability of results
Protection against climatic factors	Medium	Conditional evaluation	High
Hydrological regulation	High	Replacement cost, Conditional evaluation	Medium
Tourism	High	Travel cost	Low
Science and Education	Low	Hierarchy method	Low
Production of wood	High	Evaluation based on price	High

About usage of some soil idicators such as soil calcium and magnezium, soil moisture, soil texture, availability of base cations, and other soil resources, the purpose of all studies was to find out which of the soil characteristics influence more on the productivity of the tree stands and of the main forest species in particular.

2. Materials and methods

Assessment of forest sites in this case study located in Dragomirna Plateau, part of the Suceava Plateau, Suceava County, Romania. Stationary the studied site belongs to sessile oak phytoclimatic zone. There were studied 16 sample plots with the surface of 500 $m^{2,}$ situated in different stationary conditions (three different soil types).

In the sample plots were made 16 main soil profiles, and a series of pedological analyzes were conducted: mechanical composition (clay percentage), textural differentiation index (Tdi), degree of base saturation (V %), pH, humus content (H %).

In the sample plots were conducted a series of dedrometric measurements in order to characterize the stands such as diameter and height of each tree from the sample plot, prune height, grade, crown diameter. In order to calculate the volumes and relative production grades were determined a series of dendrometric parameters as: average diameter calculated using basal area and the average height of the average diameter as the base area.

In the research methodology were included modern statistical methods used in forestry research as correlation analysis, regression analysis, variance and specific methods and using some statistical applications such as Stat Soft 2004, Microsoft Office Excel. Soil analyses have been conducted in the Suceava pedological laboratory (O.J.S.P.A).

3. Results

Correlation coefficients analysis shows that in the case of average pH (soil acidity) values and the organic material (humus) content in the superior horizon, the connection to average relative production class is moderate and significant (Table 3).

For the clay content percentage from B-horizon, and also the textural differentiation index the correlation is strong.

Table 3 Coefficients of the correlation between average production class (CLP) and soil related factors (Savin, 2011)

Coefficients	*clp = f (pH, H, V, A, Tdi)*	*clp= f (pH)*	*clp= f (H)*	*clp= f (V)*	*clp= f (A)*	*clp= f (Tdi)*
Correlation coefficients *r*	0,854	-0,617	-0,525	-0,478	**0,746**	**0,752**
Significance (p)	0,0197	0,0143	0,0447	0,0712	0,0014	0,0012

Table 4 Correlation coefficient values for oak (Quercus petraea Lieb.)

Soil characteristics	pH med	H (%)	V med (%)	A (%)	Idt
Correlation coefficient r (Spearman)	0,450	**0,578**	-0,300	0,456	**0,628**
Significance (p)	0,1066	0,0477	0,2981	0,1011	0,0162

An analysis of the influence of soil factors on relative production class for one species revealed that for oak (*Quercus petrea Lieb.*) for example, the correlation between production class and Tdi (textural differentiation index) is moderate and significant (r =0,625) (table 4).

4. Discussion

A severel research paper releaved a strong connection between the levels of basic cations (calcium and magnesium) and the degree of nitrification. This research team concluded that from all elements, calcium has the strongest correlation with the above-ground woody biomass production (coefficient r^2=0,72). (Baribault, et al. 2010). Same studies also releaved that foliar biomass production is correlated with NO_3 levels (r^2 = 0,51). The correlation between wood biomass production and calcium from the soil was only r^2 = 0,42, and r^2 = 0,36 for nitrification degree. Low calcium content has a negative influence on growth and immunity to disease. Individual tree growth depends on calcium levels, which influence also the fine root system. (Gradowski & Thomas 2008).

5. Conclusion

In USA, France and other European countries quantification of the site fertility is based on biometric data recordings of some representative tree populations of the main forest species. Parameters as values of average annual growth, dominant height and others, gathered in synthetic productions tables, and comparative graphical representations define the site potential.

Productivity of one species in a particullary site can be quantified by measuring the mean increment of volume at a particullary age, or by volumetrical maximal growth. However, these growth values are difficult to estimate if are not used standardized production tables adapted for each forest species in particular (mainly in France). In this respect, it is routinely used an expedient method for assessing the productivity using the dominant height wich one tree population can reach an certain reference age, height referred to as "fertility index". The motivation for using the value of the dominant average height is given by the fact that conducting stand interventions, thinning, have little effect on it.

In conclusion, for a wide range of treatment methods in uniform system tree stands dominant height growth merely depends on the stationary conditions (environments). In this case, the fertility index overlaps with the notion of timber production.

In our case study of all the soil characteristics taken into consideration, clay content in B-horizon (A% from B) and Idt (textural differentiation index) are strongly and distinctly significant correlated with average relative production class, and so a key role in determining stand productivity.

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Aspects Regarding the Floristic Diversity in the Stands Situated on the Eastern Slope of Stânişoara Mountains and the Influence of the Regeneration Cuttings Upon it

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Abstract: The flora diversity is characterized by the species richness (type), the abundance (A) and the density (D). We have in view three types of regeneration cuttings single tree selection system, shelter wood system and clear cut. The ground data were collected from 43 control sample plots situated on the Eastern slope of Stanisoara Mountains in the Forest District Vama, Gura Humorului, Malini, Rasca, Pipirig, Tg. Neamt, Varatic and Garcina. The highest specific diversity can be found in clear cut stands, a lower diversity in shelter wood system and the lower one in single tree selection system.

Keywords: species richness, density, regeneration cuttings.

1. Introduction

The present work has as purpose to establish the diversity of the vascular plants and the influence of different types of forestry cuttings on their diversity on the Eastern macro-slope of Stânişoara Mountains.

The flora in this area has been partially studied on the western slope of Stanisoara Mountains and it does not provide technical forestry analyses (Zamfirescu, 2007).

2. The location of the research

The research was carried out in the forestry ecosystems where there is a mixture of beech and resinous trees, on the Eastern macro-slope of Stânişoara mountains (fig.1), identified, by the Forestry Administration, within the Forestry district of Pipirig, Târgu Neamț, Văratic and Gârcina from the Neamț Forestry Administration.

3. Research method

3.1. Choosing the areas to be studied

Experimental devices were identified, made of two or three sample plots (fig.2): a control plot variant not thinned with cuttings (indicated as "m") and the others being in different stages of the regeneration process (indicated as "p").

For choosing the stand, the first criterion was the age, the ones close to the age of being cut and which presented an irregular structure (uneven, relatively uneven or at most relatively even stand) being preferred. There were chosen the control stand where the anthropic impact was as reduced as possible.

At the same time, we looked for different types of regeneration cuttings and we identified shelter wood systems, single tree selection systems and clear cuttings.

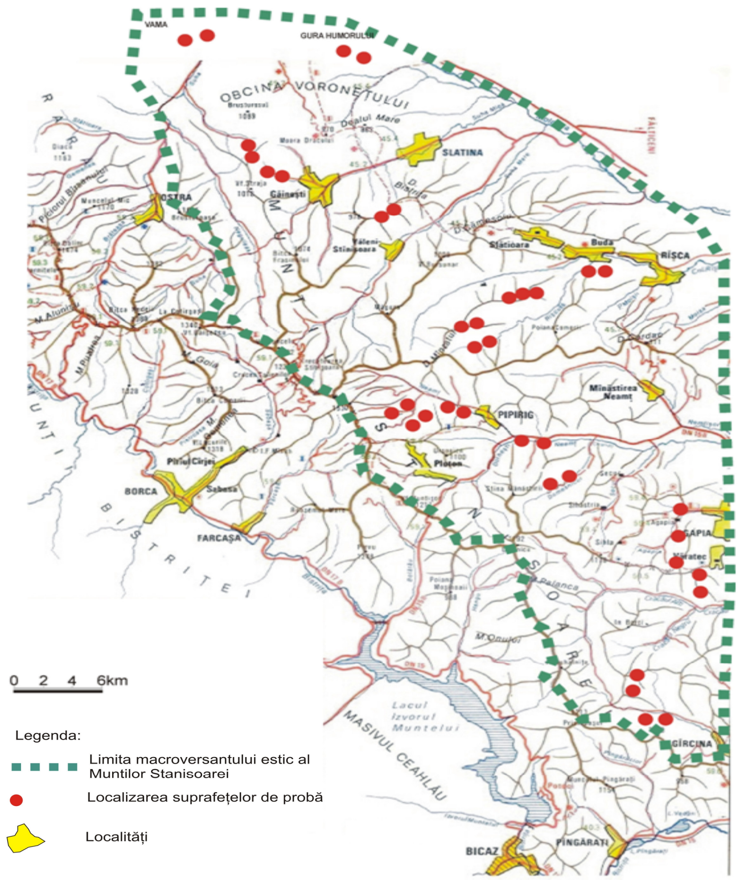

Figure 1. The distribution of the experimental devices in Stânişoara Mountains

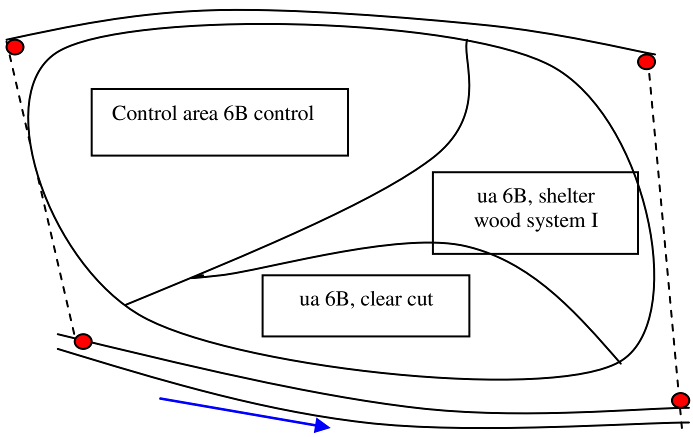

Figure 2. The sketch of the experimental device with three sample plots

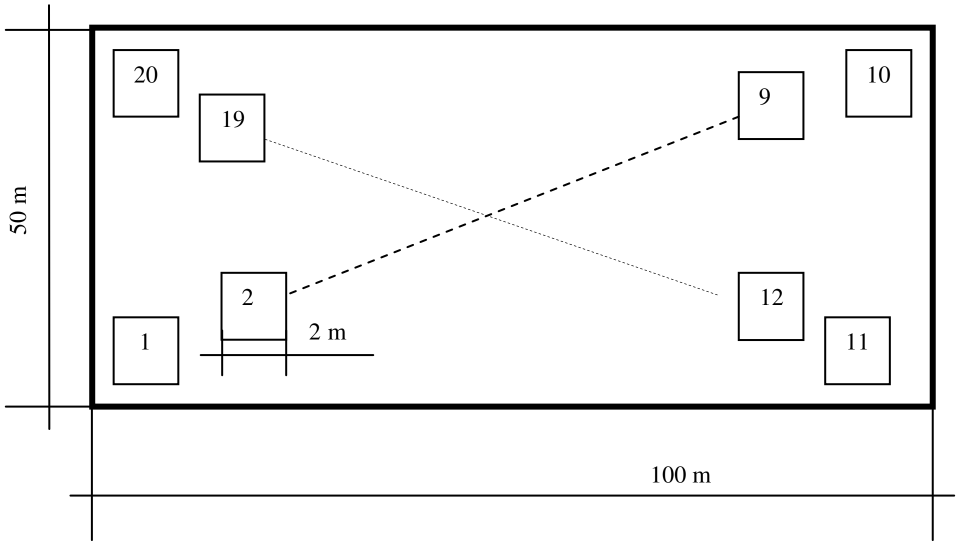

Figure 3. Sketch of a sample plot

3.2. The evaluation of the floristic diversity

The following indicators were chosen in this stage, for the evaluation of the floristic diversity (Magurran, 1988):

- richness species (of type β);
- abundance (A)

4. Results

4.1. Richness in species

The study refers to the floristic diversity of type β, used to determine the differences between the habitats of a single area (the compact forest on the Eastern slope of the Stânişoara Mountains).

For the majority of the experimental devices, sample stand – stand with regeneration cuttings, the number of species is different, in the sense that there are less samples and more in the one with clear cutting (table 1, fig. 4). An exception is the couple CIII, where the number of species in the sample is higher that the number of species in the clear cutting and in the case of the stand couples in u.a. 54m and u.a. 55p, the number of species is the same. Both of the particular cases are to be found within the single tree selection system. The fact can be explained by the variation in the environmental factors, and especially the amount of light that penetrates the stand.

The centralization of the results with identified number of species is presented in table 2.

As noticed in table 3 and fig. 4., the number of species significantly increases in the case of the clear-cut stand (52%), in comparison with the thinned with cuttings ones (29%), and, at the same time, the difference is high between the latter compared with the single tree selection system stand (19%).

Table 1. Identified number of species in the sample areas in all the analyzed variants

Couple	Variant	Identified number of species	Couple	Variant	Identified number of species	Couple	Variant	Identified number of species
Single tree selection system			Shelter wood system			Clear cut		
III	79B m	36	I	4C m	18	XI	38 m	30
	3D p	32		4C p	40		38 p	40
IV	19A m	30	II	55C m	9	XII	36A	17
	28A p	40		56A p	21		37A	34
V	19A m	30	VI	166A m	19	XIII	14F m	32
	23 C p	41		165A p	27		14B p	38
VII	174B m	9	IX	7A m	13	XVI	6B m	20
	2A p	27		7B p	30		6B p2	109
VIII	57C m	16	XIV	50A m	28	XVII	4B m	45
	171A p	23		40 p	39		4B p	95
X	54 m	7	XV	38A m	25	XIX	139A m	30
	55 p	7		37A p	30		139A p	119
			XVI	6B m	20	XX	2D m	32
				6B p1	32		2D p	50
			XVIII	44A m	47	XXI	169A m	25
				44A p	55		168B p	57

Table 2. The number of species identified in the sample areas

Type of cutting	Number of species	Variant	Number of species
Single tree selection system	96	Control plot	140
Shelter wood system	148	Thinned with cuttings	260
Clear cut	266		
Total number of species identified in the analyzed area			283

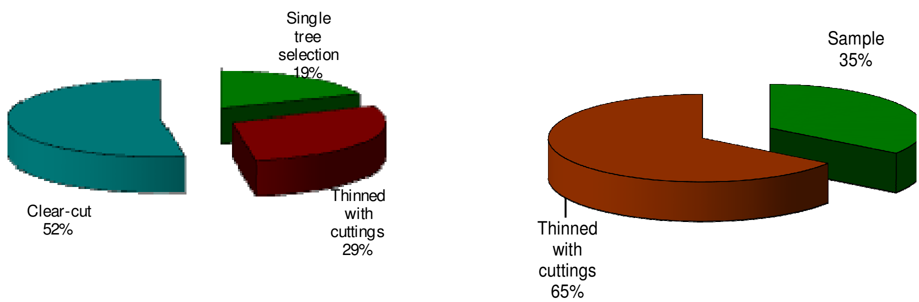

Figure 4. The number of species identified in the stands thinned with different types of cuttings and also in the control plot variants, compared with those thinned with regeneration cuttings

The difference in the number of species between the sample and the thinned with cutting stands is variable, and it depends on more factors, the most important being: the type of intervention, the intensity of the intervention, the frequency of intervention and the degree of development of the seeds.

283 species of plants have been identified, out of which 16 are trees, 21 are shrubs and 246 are herbaceous, as it can be observed in table 3 and figure 5.

Table 3. Percentage of identified trees, shrubs and herbaceous species

Nr.	Species…………..	Number of identified species	Percentage (%)
1	Herbaceous	246	86,9
2	Shrubs	21	7,4
3	Trees	16	5,7
Total		283	100

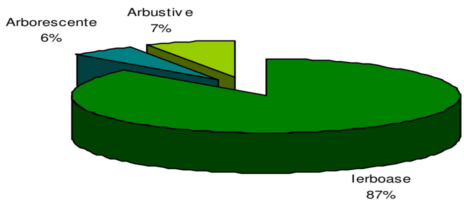

Figure 5. Percentage of trees, shrub and herbaceous species

4.2. Abundance of species

The relative abundance of a species represents the proportion between the number and/or the biomass of the individuals belonging to one species in relation with the one of other species, at a given moment (Măciucă, 2004). Regarding the abundance calculation, every phytocenotic layer and the stand as a whole were taken into account.

For the characterization of the specific diversity, from the abundance perspective, its variation coefficient was used, its values being presented in table 4. The abundance variation coefficient (Horodnic, 2004) ranges within a wide extent of values for the herbaceous, the shrub and the tree layer, as well as for the stand as a whole. These values are in relation with the identified number of species and we will continue monitoring how the abundance variation coefficient varies in species for the stand, for the herbaceous, shrub, and tree layer, as for as for the cutting type.

It can be observed that the values decrease from the herbaceous to the tree layer, fact which is explainable by a decrease in the number of species from the herbaceous to the tree layer (fig. 6). By analogy, when the same correlation was analyzed, but comparing the control stand with those thinned with regeneration cutting (fig. 7), we observed that the correlation is tighter for the control stands, fact that can be observed both in the value of the correlation coefficients, as well as the direction of the diagram axis.

Table 4. The values of the abundance variation coefficients for the analyzed area

Type of cuttings	Variant	Number of identified species	Individuals …………...per hectare			The values of the abundance variation coefficients for the analyzed area			
			Herbaceous	Shrub	Trees	Herbaceous layer	Shrub layer	Trees layer	Stand as a hole
Single tree selection	79B m	6	618000	93000	126	100,941	183,214	127,306	136,522
	3D p	2	749000	18625	90	117,784	133,175	133,175	137,217
	19A m	30	899250	9125	364	138,592	108,430	105,677	158,360
	28A p	40	1013250	29500	104	131,68	78,738	98,303	146,064
	19A m	30	899250	9125	364	138,592	108,430	105,677	158,360
	23C p	41	835500	71375	84	154,725	172,148	60,609	160,658
	174B m	9	31250	19500	252	68,411	125,104	123,463	111,322
	2A p	27	375500	17875	216	123,105	100,964	125,708	142,415
	57C m	16	153500	10500	258	115,048	77,445	38,370	131,441
	171A p	23	183000	28375	154	118,616	82,505	119,382	122,173
	4C m	18	181000	14875	124	101,479	91,508	113,512	120,739
	4C p	40	669500	57875	98	98,4309	119,929	136,948	108,171
Shelter wood system	55C m	9	183250	37125	184	38,642	-	71,177	105,113
	56A p	21	271250	29500	112	143,031	117,452	91,124	154,847
	166A m	19	96500	21625	216	119,843	143,337	15,713	130,246
	165A p	27	181000	29000	212	118,197	124,983	114,022	133,958
	7A m	13	89000	750	182	60,1245	47,140	-	73,792
	7B p	30	109750	875	152	141,799	101,015	133,978	155,041
	50A m	28	135500	29000	572	143,743	58,519	192,718	150,103
	40 p	39	336500	34500	338	191,115	121,681	123,011	189,640
	38A m	25	140750	13125	282	152,445	1,347	147,451	177,235
	37A p	30	149250	14625	142	127,358	140,043	119,760	146,010
	6B m	20	112250	13750	264	46,591	131,136	27,555	71,662
	6B p1	32	390000	22750	184	110,915	147,519	96,421	110,915
	44A m	47	311000	5250	424	134,108	94,281	115,233	158,676
	44A p	55	336500	7250	56	109,079	74,558	93,610	120,833
	38 m	30	97250	8000	268	59,311	125,727	86,313	77,130
Clear-cut	36A	17	76750	7250	258	57,458	87,779	71,641	81,060
	37A	34	97750	2875	-	92,126	65,651	-	99,252
	14F m	32	481250	8000	218	80,4763	86,873	164,071	112,858
	14B p	38	154250	4875	-	76,895	117,065	-	88,798
	6B m	20	112250	13750	264	46,591	131,136	27,555	71,662
	6B p2	109	322875	40500	-	153,859	137,350	-	153,269
	4B m	45	137500	32000	182	110,689	132,369	94,710	126,608
	4B p	95	203000	10375	-	132,130	82,293	-	129,567
	139A m	30	68000	1500	98	123,550	47,140	99,729	137,664
	139A p	119	855250	27250	-	287,937	152,963	-	284,703
	2D m	32	441250	12750	248	87,9479	107,440	91,835	123,695
	2D p	50	206000	2375	-	160,309	63,812	-	164,676
	169A m	25	400000	9500	274	120,763	107,927	137,292	133,875
	168B p	57	239250	13625	-	112,177	233,008	-	122,659

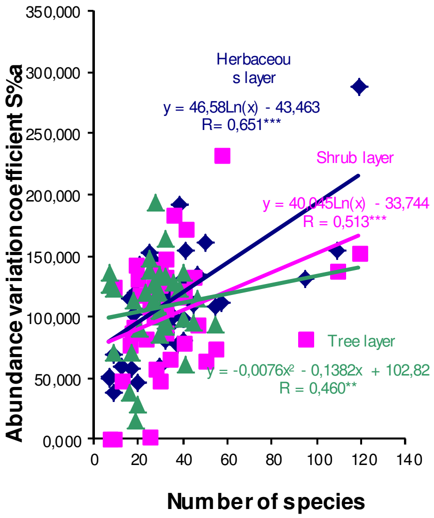

Figure 6. The way of variation of the abundance variation coefficient s% a for each layer in particular, with the number of species for all the analyzed stands

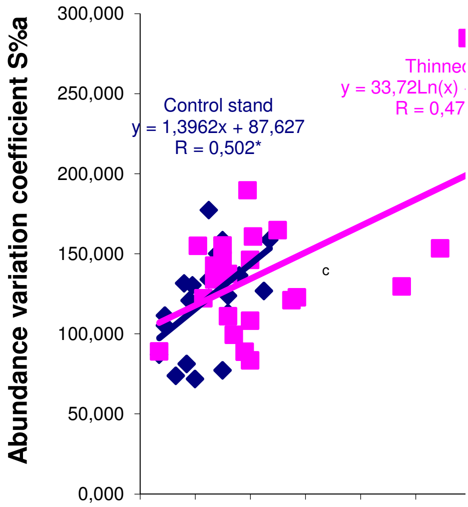

Figure 7. The variation of the abundance variation coefficient s% a with the number of species for the control stands and for those thinned with regeneration cuttings, for all the stands

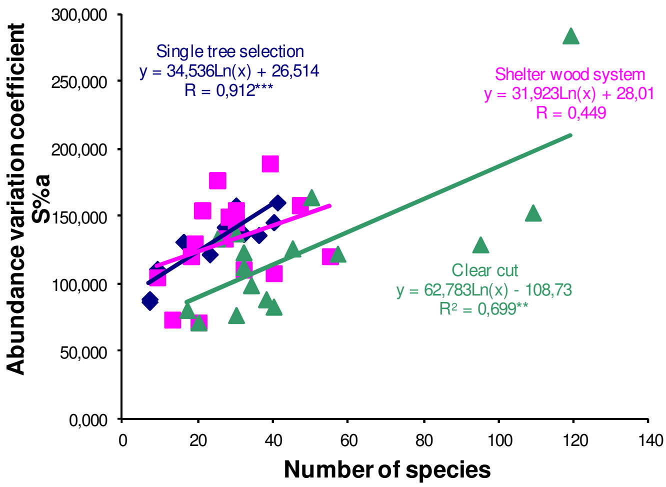

Figure 8. The way of variation of the abundance variation coefficient s%a depending on the number of species split into types of cuttings for the experimental devices

In fig. 8 we followed the correlation between the number of species and the abundance variation coefficient, depending on the type of regeneration cutting.
When analyzing the couples of variants thinned with different cuttings, the same tendency is to be observed: the increment of the variation coefficient with the number of species (fig. 8). The value of the correlation coefficient is significant for the stands thinned with single tree systems and distinctly significant for the clear cutting. In the shelter wood system we can observe only an increment tendency, but the correlation is very weak. The reason for this is the technique of the treatment, which involves relatively frequent interventions (three – years). Both in openings, as well as in enlarging the opening, the ground, the herbaceous bedding the seeds and the shrub layers are affected and, thus, the number of existent species decreases.

5. Conclusions

In the 21 experimental devices, 43 variants, 283 species of vascular plants were identified. The number of species is the lowest in control stands (141), where the anthropic intervention was relatively small and a lot higher (261) in those thinned with regeneration cutting. As far as the type of regeneration cutting is concerned, within the devices where the single tree selection system was to be used, we found the lowest number of species – 97, in those with shelter wood – 149 and those with clear cut – 267 species. 6 species that are on the “Romanian red list of plants” were also found.

For the characterization phytocenosis from the abundance point of view, the abundance variation coefficient was used (s%a). generally, it increases with the number of species, but in a different way for each vegetation layer or for every particular type of regeneration cutting. The most important increment is in the herbaceous layer, less in the shrub layer and the smallest one in the tree layer, the explanation being the number of species – decreasing from the herbaceous to the tree layer.

This variation mode can also be observed in the comparative analysis between the control variants and those thinned with regeneration cuttings. In the control stand, in all cases, both for the stand as a whole, as well as for each particular layer, the abundance variation coefficient increases with the number of species, the correlation coefficient decreasing from the herbaceous to the tree layer. We observe the same situation in the case of the variants for the herbaceous and the shrub layer. We also took into consideration the extreme situations (null values), as they represent a certain state, given by a certain type of anthropic intervention. When the same correlation was analyzed, but depending on the type of cutting, we observed that, in the case of the single tree system stands and the clear cut ones, the correlation coefficients are very important.

In the case of shelter wood system, there is no correlation between the abundance variation coefficient and the number of species. The reason for this is the technique of the treatment, which involves relatively frequent interventions (three – years). Both in openings, as well as in enlarging the opening, the ground, the herbaceous bedding the seeds and the shrub layers are affected and, thus, the number of existent species decreases.

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Effects of alterations of Romania's forestry stock area and structure on diurnal Lepidoptera – a GIS approach

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Abstract: The area and especially the structure of Romania's forestry stock have suffered serious alterations in the last 50 years (Biris and Veen 2005). The consequences of this alteration is reflected not only on big mammals and birds but also on insect communities, of which the butterflies are considered excellent indicators of changing environment (Erhardt 1985, Van Sway and Warren 1999). Natural or semi natural forests (biologically important forests - BIF) are the ones that preserve the real biodiversity. The reduction of forests' area from 79% of Romania's territory to 26.7% in the last century (Biris and Veen 2005) has a negative impact on characteristic woodland butterfly communities (Schmitt and Rákosy 2007). Based on GIS modelling (overlay methods), the authors develop and highlight several positive and negative scenarios for the evolution of woodland butterfly communities in Romania for the next 50 years.
Negative scenarios result in the decline of butterfly species of the hilly floor, followed by the species of the mountain floor. Strictly protected species suffer a decline with the decline of BIF area, whereas other species take advantage of the extension of allochtonous trees and increase their distribution and abundance. These scenarios are backed up by examples from the past: *Neptis sappho* has extended its trophic base from *Lathyrus niger* and *L. hallersteini* to *Robinia pseudoacacia*, taking advantage of this species' expansion (*R. pseudoacacia* is widely used all over the country); *Lycaena helle* suffered from natural succession that lead to the disappearing of wood clearings; *Leptidea morsei* suffered a reduction of its populations because of the destruction of the herbaceous ground vegetation as a consequence of oak wood deforestation.
Positive scenarios, on the other hand, show that adequate conservation measures applied in managing the forestry stock of Romania will result in healthy populations of several protected butterfly species and thus healthier woodland ecosystems overall.

Keywords: butterfly communities, forest structure, management, GIS-modelling

1. Introduction

In pre ancient times, before massive human intervention on the forests, Romania's territory was over 70% covered with forests (Pop, 1942). The Carpathian forests were connected with the alluvial forest of the Danube basin floodplains. Chroniclers report unreachable forests in all of today's Romanian historical provinces (Giurescu, 1976). Today only 26.7% of Romania's territory is covered with forests (Biris and Veen, 2005) (Fig. 1).

The flora and fauna have evolved in close connection with the geoclimatic conditions but also with the ratio forest-open land, influenced by the presence of wild herbivores, but also because of the accidental or intentional fires lit by Neolithic man (Rákosy, 2011).

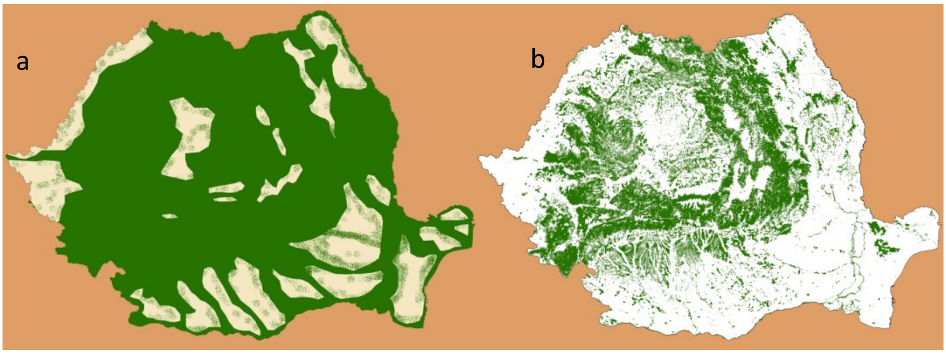

Figure 1. a) Ancient forests – over 70% (Pop 1942, adaptation) and b) Romanian forests today - about 27% (Corine Land Cover 2006)

In the first phase of this process, the number of plant and animal species closely connected to the forest was larger than that of the open land areas. Under the influence of man, this ratio changed, open land areas harbouring today most of the biodiversity.

100/150 years ago the two big habitat types: forest – open land, were balanced. The human expansion that still goes on reduces and fragments the forest areas. The consequences of the reduction of the forest area and its fragmentation are felt not only by the big mammals (bear, wolf, lynx etc.), but even more so by invertebrates.

The butterflies are a flagship group of invertebrates (Kudrna, 1986, Pollard and Yates, 1993, Thomas and Clarke, 2004, Thomas, 2005), which is very attractive and loved by many. Even though there are few typical forest butterfly species (20 species closely connected to the deciduous forests Appendix 1), they are sensitive indicators and they accurately and constantly react to habitat changes (Erhardt, 1985, Hacker and Müller, 2006, Thomas, 1994, Van Sway and Warren, 1999, Thomas et al., 2004). Previous studies showed that the reduction of suitable habitat area has a negative effect on butterfly communities (Schmitt & Rákosy 2007).

Considering their sensitivity and the trend of reduction of the biologically important forests area in Romania (virgin and semi-natural deciduous forests) in the last 100 years, we hypothesize that the further reduction, in the next 50 years, of the habitat will affect negatively the overall number of butterfly species typically connected to these forests. To test this hypothesis we assessed deciduous forests and developed several scenarios (Lütolf et al., 2009, Spangenberg et al., 2010) to predict forest area and structure evolution and butterfly species richness. Because the computational effort to modelling all deciduous forests in Romania would be excessive (Reginster et al., 2010, Peterson, 2003), we have chosen a smaller representative area, located near Cluj-Napoca, covering most part of what is known to be “Fagetul Clujului” and the floodplain forests.

As a tool for testing this hypothesis we use species distribution models (SDMs) (Guisan and Zimmermann,

2000) relating species presence/absence data to physical environmental characteristics that have been proven to be valuable tools for the study of species reactions under changing environments (Bolliger et al., 2000; Stefanescu et al., 2004; Guisan and Thuiller, 2005). Such models have been increasingly used to support decisions in nature conservation planning (Glenz et al., 2001; Barbosa et al., 2003; Peterson and Robins, 2003). For that purpose, scenarios for future landscapes have often been created to provide descriptions of plausible developments (Tress and Tress, 2003; Bolliger et al., 2007). Scenarios do not claim to predict or forecast the most realistic outcome, but rather to offer a way to think about alternative directions of change (Tress and Tress, 2003).

2. Materials and methods

The investigated area near Cluj-Napoca (Fig. 2) is 31% covered with forests dominated by *Fagus sylvatica* and 69% forests dominated by *Quercus* sp. The total investigated area has a cover of 8173 ha.

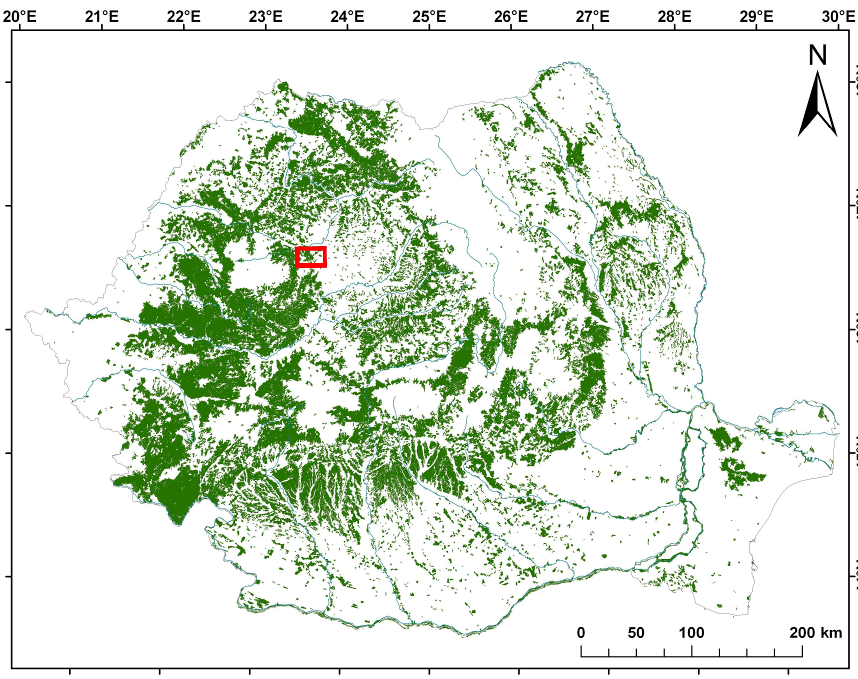

Figure 2 Romanian **deciduous** forest – 4.820.638 ha (Corine Land Cover 2006) with the location of the study area, the hills of Southern Cluj County.

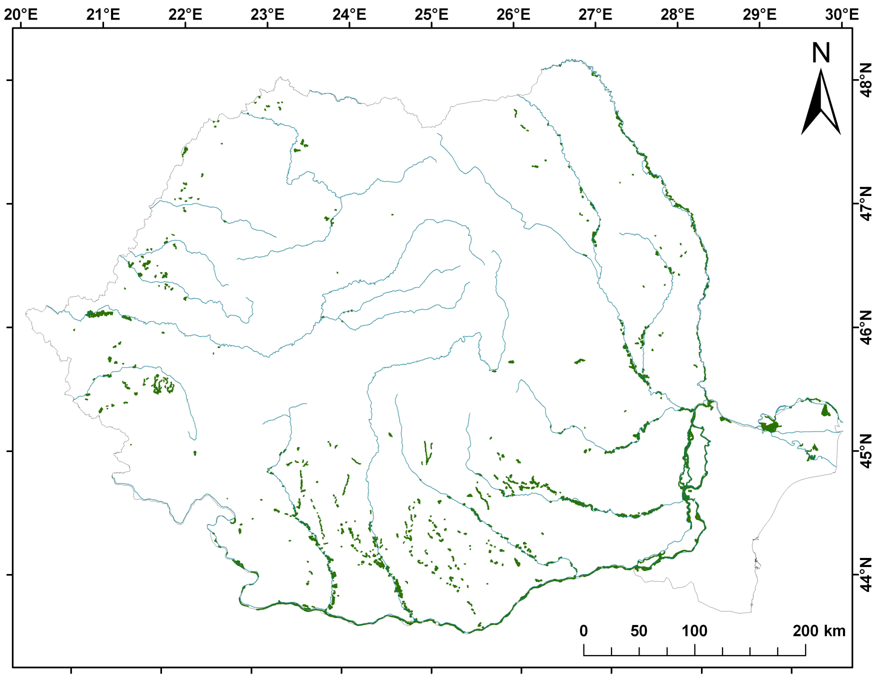

Figure 3 The map of the floodplain forests in Romania – 176.415 ha (Corine Land Cover 2006 adapted)

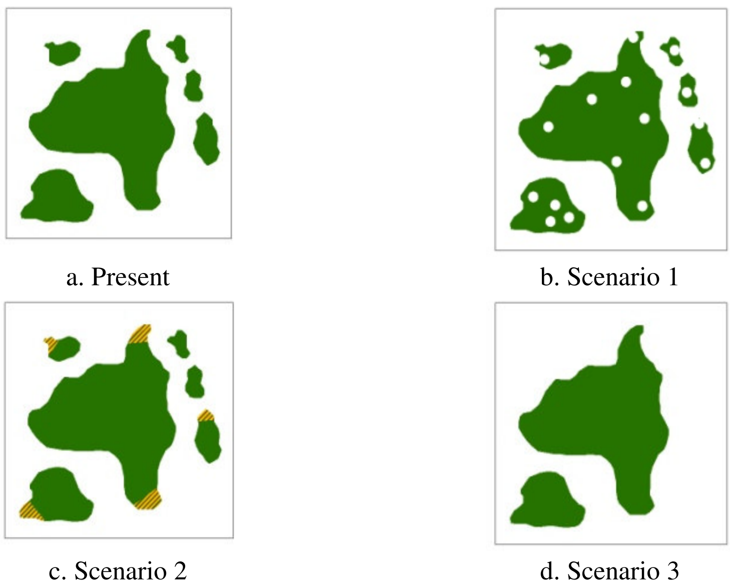

Figure 4. Schematic presentation of the 3 developed scenarios: a. present situation, b –1st scenario: cutting selectively inside the forest body, c.2nd scenario: cutting at the edge of forest bodies, d. 3rd scenario: clear-cutting of entire forest bodies

The floodplain forests of Romania cover a total of 176,415 ha (Fig. 3) and are composed of forest bodies with an area larger than 0.3 ha (Corine Land Cover 2006, http://www.eea.europa.eu/). Approximately 50,000 ha of the recorded and mapped floodplain forests are of European interest, belonging to alluvial forest type with *Alnus glutinosa* and *Fraxinus excelsior* (R4401, R4402), and to mixed floodplain forest type with *Quercus robur, Ulmus minoe, Ulmus laevis, Fraxinus excelsior, Fraxinus angustifolia* (R4404) (Doniță et al., 2005, Stăncioiu et al., 2008).

For assessing deciduous forest butterfly species richness we used records from the literature (Rákosy et al., 2003, Cremene et al., 2005) and personal experience. Butterfly species were attributed to the following habitat categories: species reproducing in forests, species preferring (reproducing and living there most part of their lives) forests, species reproducing in forest edges, species preferring forest edges, species reproducing in forest clear-cuts, and species preferring forest clear-cuts (Schmitt and Rákosy, 2007) at country level and for the investigated area in Cluj County (Rákosy, 2002, Goia and Dincă, 2006), and for the floodplains (Schmitt and Rákosy, 2007, Hacker and Müller, 2006)).

Furthermore the butterfly species were classified according to their IUCN red list category: CR – critically endangered, EN – endangered, VU – vulnerable, NT – near threatened, LC – least concern, DD – data deficient.

The information for the present forest cover of the investigated forest area in Cluj County and for the floodplain forests was calculated from Corine Land Cover 2006 Map with the program ArcMap 9.2 (ESRI, 1999).

After 50 years, considering that the forest area will be reduced by approx. 10%, 3 scenarios of cutting and their effects on the diurnal Lepidoptera were developed (Fig. 4).

First we evaluated the area and shape of the existing forest bodies (Table Attribute of studied forest shape-file>Calculate Geometry > Area, respectively Perimeter).

For the first scenario we cut from the initial polygons an area of 10% (820 ha) in the form of randomly distributed circles with a 2 ha area each. Using the Hawth's Analysis Tools 3.27 (http://www.spatialecology.com/htools/) extension we generated 410 points (HawthsTools>Sampling Tools> Generate Random Points) inside the polygons representing the forest. Around these points we created a buffer zone with an area of 80 m, resulting in circles of an approximate area of 20000 square meters (Analysis Tools>Proximity>Buffer). Next we used the function erase (Analysis Tools>Overlay>Erase) to cut these circles from the initial polygons and we calculated again, for the resulting file, the areas and perimeters of each forest body.

For the second scenario and the floodplain forests, the area of the polygons was reduced by 10% using a negative buffer for each forest body (Analysis Tools>Proximity>Buffer, 10 m for the deciduous forest near Cluj and 15 m for the floodplain forests)

For the third scenario, polygons were completely deleted, in ascendant order of their sizes, so that the remaining area would represent 90% of the initial area (Editor>Start Editing>Delete Selected).

For each scenario the shape of the forest bodies was evaluated on the basis of the ratio corrected perimeter/area (CPA), which indicates the degree of elongation in relationship with the circle of the same area (Austin, 1984, Gafta, 2002). The formula used to compute CPA was: $CPA = P/(2\pi\sqrt{A/\pi})$ where P-perimeter and A-area of the forests.

3. Results

Overall there are 20 reported butterfly species closely connected to deciduous virgin and semi-natural forests in Romania (Appendix 1). The highest proportion of these species (>60%) prefer or reproduce well in forest edges (Fig. 5).

The floodplain forests of Romania harbor 7 known typical butterfly species (Appendix 2), of which 2 are priority species.

12 forest butterfly species were identified as being present in the deciduous forests, forest edges and forest clear-cuts of the investigated area near Cluj-Napoca. 10 (83%) of these preferred forest edges and only 2 (17%) of them preferred both forest edges and forests. All identified species are reproducing in forest edges and 8 (67%) are reproducing in the forest clear-cuts. Only *Limenitis populi* (Linnaeus, 1758) and *Lopinga achine* (Scopoli, 1763) are red listed species under the category VU. Both vulnerable species were not able to reproduce in forest clear-cuts.

8 forest butterfly species were identified as being present in the floodplain forests of Romania (Appendix 2). All of them preferred forest edges and only 1 species (13%) (*Limenitis camilla*) preferred both forest edges and forests. 5 (63%) species of these are well reproducing in forests and none can reproduce in forest clear-cuts. 7 of the 8 (88%) floodplain forests butterfly species are red-listed species (*Limenitis camilla* is not red-listed). *Limenitis reducta* is endangered and the other 6 are vulnerable.

1st scenario: Decrease of forest area through cutting inside of the forest body resulted in an area decrease of 10% but a perimeter increase of 35% (Fig. 6). The CPA index also increased from 2.28 to 3.18. The higher CPA (CPA>1) value shows a more irregular shape with a stronger edge effect (Gafta, 2002). The diversity of diurnal Lepidoptera connected to forests and forest edges is not affected, on the contrary they could even benefit of this type of cutting.

2nd scenario in the area of Cluj County: decrease of forest areas through cutting at the edge of the forest bodies resulted in an area decrease of 10%, and a perimeter decrease of 5%. The CPA index remained almost the same (from 2.28 it slightly increased to 2.34), this means that the shape of forest bodies remained also the same. The diversity of diurnal Lepidoptera connected to forests and forest edges is not affected up to a certain cutting percent connected to the natural regeneration capacity of the forest eg. for species with small, island-like, populations (*Neozephyrus quercus, Satyrium ilicis*).

2nd scenario in the case of floodplain forests: decrease of the forest area through uniform cutting along the forest bodies resulted in a decrease of the number of forest bodies (from 1213 to 1135) and of the mean areas of these forest bodies (from 145 ha to 137 ha). The CPA index grew very little (from 2.02 presently to 2.1), that means that the shape of the forest bodies did not change very much. The reduction of the number and area of floodplain forests affects strongly the populations of butterfly species connected to these habitats (Fig. 7.).

3rd scenario: Decrease of forest area through clear cuts of whole forest bodies resulted in an area decrease of 10%, and a perimeter decrease of 15%. In the case of clear cuts, even of small forest bodies, woodland species are strongly affected and driven to extinction.

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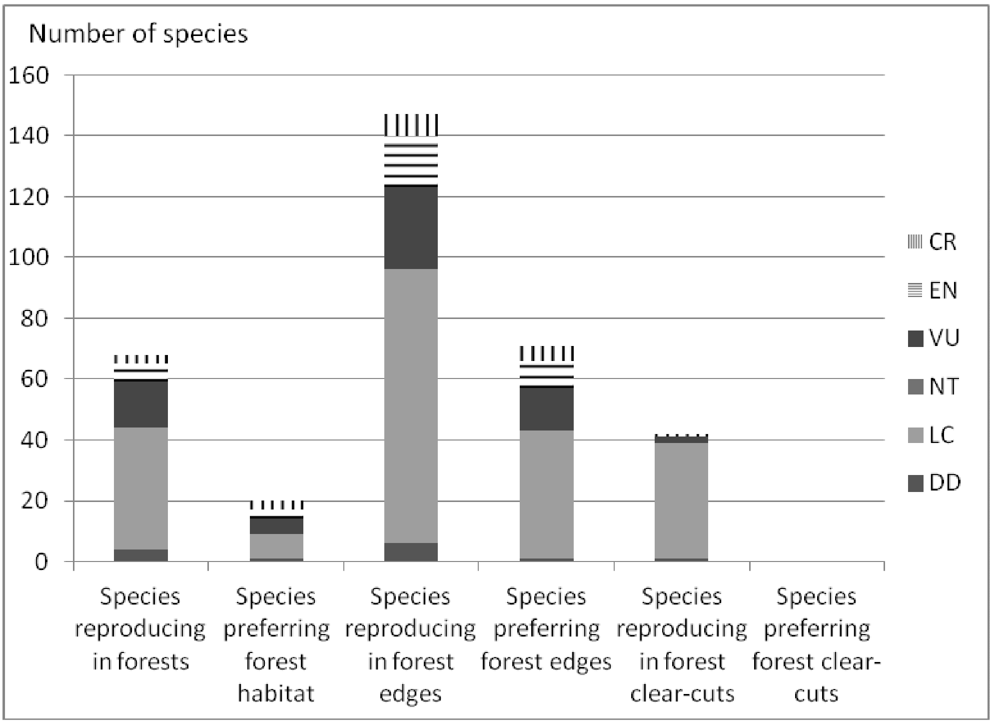

Figure 5. Number of diurnal Lepidoptera species reproducing (using forests as their secondary habitat) in and preferring (reproducing and living there most part of their lives) forest habitats, forest edges and forest clear-cuts in Romania. Abbreviations: CR – critically endangered, EN – endangered, VU – vulnerable, NT – near threatened, LC – least concern, DD – data deficient (IUCN red list categories).

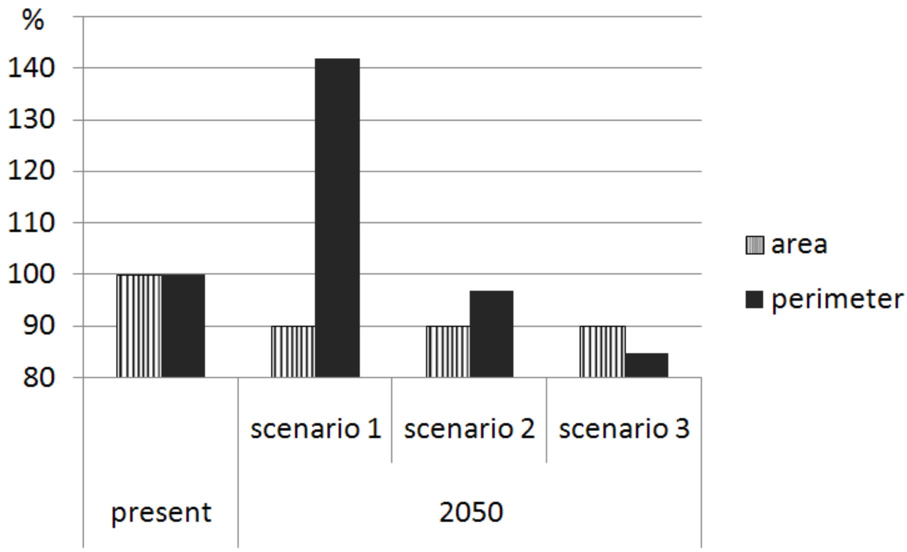

Figure 6. The proportion of area and perimeter at present and in the three developed cutting scenarios: 1 selective cutting inside of the forest body, 2 cutting at the edge of forest bodies, 3 clear-cutting of whole forest bodies

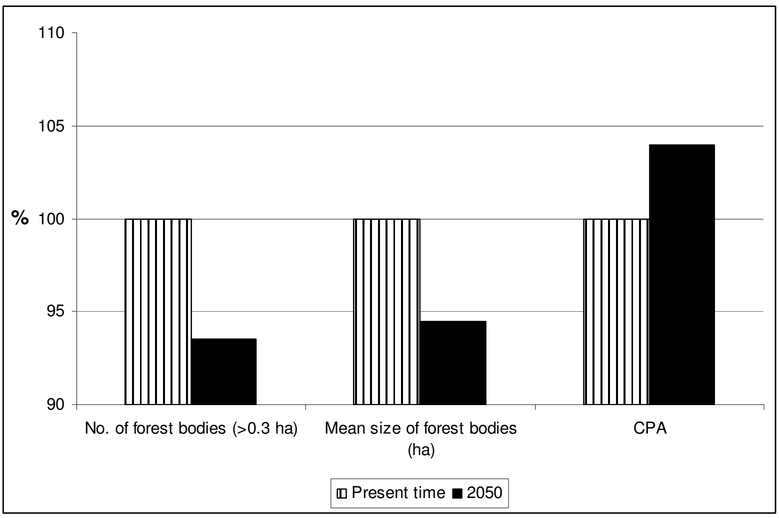

Figure 7. Proportion of number, size and CPA of floodplain forest bodies at present time and after 50 years (scenario no. 2)

4. Discussion

Butteflies are sensitive indicators of habitat change and are a flagship group in conservation (Erhardt, 1985). Previous studies showed that the reduction of suitable habitat area has a negative effect on butterfly communities (Schmitt & Rákosy 2007). To be able to conduct a sustainable forest management it is necessary to use indicators that will accurately reflect the level of biodiversity.

The total forest cover of Romania does not necessary represent good habitat for butterflies. Biologically important forests (BIF) are habitats of deciduous forests with a high value for many animal and plant species. They harbour the real forest diversity. The cover of these forests is considerably lower compared to the total forest cover of Romania (4.820.638 ha compared to a total of 6.380.000 ha) (Stăncioiu et al., 2008) and is at risk to be reduced even more because hardwood is preferably exploited for industry and home use.

Our study shows that different scenarios of cutting have different outcomes on the butterflies typically connected to deciduous forests.

Because most forest butterfly species prefer or reproduce well in forest edges, this is an important factor for their distribution. The first scenario of selective cutting inside the forest bodies would be the best solution for sustainable long term management of forests because this type of cutting favors the elongation of the forest area, the increase of forest edge and thus allows the persistance of typical butterfly communities.

The second scenario resulted in a very small modification of forest body shape. This type of cutting would not strongly affect populations of forest butterflies unless they are applied in narrow distribution ranges of several species with small, island-like populations (eg. *Neozephyrus quercus, Satyrium ilicis*). Therefore we recommend a thorough assessment of the presence of such species in the area where such pattern of cutting would be applied before this measure would be applied.

In the case of floodplain forests only the second cutting scenario was plausible. These forests are extremely important for a series of butterflies. They have been exploited and reduced considerably and often neglected from the point of view of administration. Some alluvial forests are sometimes not even classified as part of the forestry stock. Through the reduction of their area and the practice of cutting Salix branches, populations of all floodplain forests butterflies are strongly affected, some of them being priority species or species of European interest: **Euphydryas maturna, Limenitis populi, Limenitis camilla, Limenitis reducta,* **Apatura metis, Apatura ilia, Apatura iris*. The further reduction of these forests could lead to the disappearance of populations of some endangered butterfly species and even to the total loss of such species from Romania's fauna.

The third scenario is the most pessimistic one. The clear-cutting of whole forest bodies would be detrimental to populations of all forest butterfly species.

The disappearance over large areas of suitable habitat would lead to isolation between populations, the halting of gene flow, inbreeding depression, and finally loss of populations (Gafta 2002, Santana et al., 2011). In case of the already isolated small populations of butterflies this type of cutting would have disastrous effects leading to total extinction of the species. We thus strongly advise against this type of cutting.

Our results show that an area reduction of forestry stock is not necessary detrimental to butterflies if correct management strategies are applied, i.e. selective cutting inside of the forest bodies. Our recommendations for deciduous forest management take into consideration only butterflies, but because butterflies are good habitat quality indicators, by applying adequate forest management strategies to protect them, other species of plants and animals will also benefit.

Appendix 1. List of butterfly species closely connected to (preferring) deciduous virgin and semi-natural forests in Romania
Neozephyrus quercus (Linnaeus, 1758)
Tomares nogelii dobrogensis (Caradja, 1895)
Satyrium w-album (Knoch, 1782)
Satyrium ilicis (Esper, 1779)
Everes alcetas (Hoffmannsegg, 1804)
Libythea celtis (Laicharting, 1782)
Boloria dia (Linnaeus, 1767)
Nymphalis vaualbum ([Denis & Schiffermüller], 1775)
Limenitis camilla (Linnaeus, 1764)
Kirinia roxelana (Cramer, 1777)
Pararge aegeria tircis (Butler, 1867)
Lasiommata maera (Linnaeus, 1758)
Lopinga achine (Scopoli, 1763)
Hyponephele lupinus (O. Costa, 1836)
Erebia ligea nikostrate (Fruhstorfer, 1909)
Erebia euryale syrmia (Fruhstorfer, 1919)
Erebia aethiops aethiops (Esper, 1777)
Hipparchia fagi (Scopoli, 1763)
Hipparchia syriaca (Staudinger, 1871)
Hipparchia volgensis delattini (Kudrna, 1975)

Appendix 2. List of butterfly species closely connected to (preferring) floodplain forests in Romania
**Euphydryas maturna* (Linnaeus, 1758)
Neptis hylas (Linnaeus, 1758)
Limenitis populi (Linnaeus, 1758)
Limenitis camilla (Linnaeus, 1764)
Limenitis reducta (Staudinger, 1901)
**Apatura metis* (Freyer, 1829)
Apatura ilia ([Denis & Schiffermüller], 1775)
Apatura iris (Linnaeus, 1758)

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The risk of fire and it´s management in the forest of Suceava County

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Abstract: The paper aims to identify and diagnose the risk of fire in the forests of Suceava County, approaching the activity from the point of view of the fireman acting to implement the measures of prevention and fire fighting, as well as from the point of view of the one who organizes, coordinates, leads and carries out activities of limitation and extinction of the fires affecting the forest fund. Therefore, after a brief overview of the defining elements of Suceava's forest fund, of the importance and the role of the forest in the life of the county, we will move on to the development of a risk analysis, pointing the risk factors with an active or potential presence. The presentation of a few elements of risk theory, which places landmarks in a research of this kind, creates the premises of an objective approach, concrete and with commensurable results of the fundamental elements that define the risk of fire in the forests of Suceava. The risk factors are presented and analysed according to their presence and influence, the dimensions of their consequences and the frequency of risk manifestation. Also, the risk factors are each analysed, both in terms of the natural and anthropogenic contribution and the way in which they manifest their presence in the production of the risk fire: as determinants or as situational factors.

Keywords: risk of fire, natural risk factor, anthropogenic risk factor, forest fire.

1. Introduction

Each system has the protection which it can afford. Thus, the risk it assumes is inversely proportional to the level of protection achieved. At the same level of risk, different measures of protection can be adopted, depending on the stage and the system development, the importance and the interest manifested in the functioning or the disturbance of its smooth functioning or in different systems (Şerbu, 2002). It is widely agreed that practically, there is no natural or anthropogenic system that can function at risk "zero". The risk of fire, particularly the forest risk fire has always existed and will always exist, independently from the human will and action. Thus, it is well known the fact that for a fire to start, three elements have to be simultaneously met, in the same area: the carburant – the combustible material which has the property of burning, the carburant – the gas which favours and maintains the combustion and the source of ignition – which has to provide the temperature necessary to the ignition of the carburant, depending on the time in which it is in contact (Adam, 2007).

Summarizing, when analysing the risk, the following structural relations have to be taken into consideration:

- the type and the dimension of the consequences / losses that are likely to occur;
- the probability / the frequency of production;
- the entity (persons, goods, environment) at risk;
- the value of the losses expected to occur, estimated according to the worst scenario;
- the value of the compensatory measures to be taken in order to minimize the risk.

2. Materials and methods

The history of the emergency situations produced because of the risk of fire in forests, in the area of expertise – Analysed period January 1990 – September 2009 shows that during this time at the level of the Forest Directorate Suceava were 132 forest fires (IES). The presentation is done without considering the indicator “damage value” or “consequences of fire” because it could include too much subjectivity. Graphically represented, the distribution of fire on years, does not allow seeing their downward trend, but a situational evolution, with peaks between 19 and 25 fires per year, which represents two fires per month.

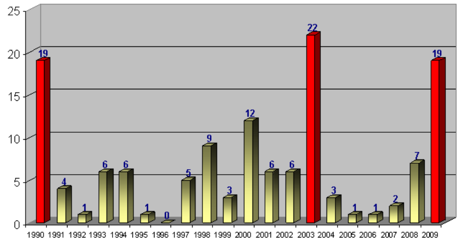

Fig. 1 - The analysis of forest fires during 1990 – 2009

The analysed risk factors influence, under one form or another, the burning rate which is a main characteristic of combustible substances and materials and it depends, in the case of forest fires, on: the temperature at which the first oxidation reaction takes place; - the chemical composition, - the humidity of the substance or of the combustible material; - the air currents; - the atmospheric pressure; - the ratio between the free surface and the volume of the combustible material.

The identification of the risk factors of fire for the forests of Suceava has to be done separately, dealing with the two major influences – nature and man, in this way:

a) natural factors

The natural risk factors of the forest fires, predominantly in Suceava County, are:

- the forest fund;
- the climate, the atmospheric pressure and the air currents;
- the landforms;
- the hydrographical network;

The forest fund is the main combustible material from the forests. The forests from Suceava County are rich and diverse in species, mainly predominant are the coniferous forests – 76%, among which the spruce contributes with 64% to the forest fund and 84% to the coniferous forests (DS).

Analysing the annual number of fires, it can be observed the fact that the climatic factor (high temperatures and drought) significantly influenced the number of fires, this being higher in the dry years and higher than normal temperatures for that period.

This value is directly related to the atmospheric pressure, which is higher on a sunny weather, than on a changing weather. The lowering of the atmospheric pressure reduces the burning rate, while its increase accelerates it.

The excessive humidity reduces the burning rate, while the high drought, increases it substantially. The air currents – the wind – have a greater influence upon the burning rate of the combustible materials.

At the mountains, where the forests prevail in Suceava County, the air currents are always present, and on strong wind, the burning is intensely fuelled with oxygen, hence the burning rate is also accelerated. Also, due to the wind, annually, in the Suceava forests, about 60.000 cubic meters of timber are being cut (DS). This timber, from the natural drying to the parquet exploitation, leads to the increasing of the risk fire, exponentially towards the exploitation on the foot.

The topography influences the risk of fire through the implications that it has on the currents of air and through the positioning of the stand in slope, it leads to a rapid spread of fire on height. Also, the mountain *soil* is loose, consisting layers of litter, which allows and promotes the accumulation of oxygen, with direct consequences for the development of forest fires in the underground.

In the case of the mountainous terrain, the risk of forest fire determined by *the electrical discharges* from the atmosphere has to be treated separately.

As a natural risk factor, but which indirectly influences the ignition and the spreading of the fire, the hydrographical network contributes more to the influence of the time necessary for the intervention operations, so through its presence and volume, it can decide the extent of the spreading of the forest fire.

In the case of the forests from Suceava county, with a hydrographical network of 1370 km, of which 395 km of rivers, 975 km of streams and 0,31 km of lakes and ponds, compared to an area of 439.862 ha, it results a density of water courses of 0,003 km/ha of forest fund (DS). This low density of water courses combined with the lack of facilities and hydro reservoirs, which should provide a certain and stable water reserve, with a reduced availability of the means of intervention – a total number of 48 alimentation ramps for the intervention machines, as well as an uneven distribution in the territory, lead to a negative influence in the rising risk of fire in the forests of Suceava county.

b) the anthropogenic factors

The anthropogenic factors of risk concerning the forest fire, predominantly in Suceava County are:

- the form and the type of ownership/management/exploitation of forest.

- **t**he human activity in the forest area in the form of:

- The roads
- The railway network
- The power lines of medium or high voltage
- The forest exploitation activity
- The tourism activity
- The existence of drilling and operating wells for natural gas deposits
- The hydro technical facilities
- The constructions of worship
- The psychosocial profile of the population and its economic status.

- The form and type of ownership/management/exploitation of forests is a key factor in the determination of the anthropogenic risks. Analysing the causes which led to the ignition of the forest fires during 1990 – 2009, the top is the intentional action 35% and the fire outside the forest 34% (Crăciun et al. 1999; ISU; IES; ISU 2010).

- The human activity in the area of the forest is present in various forms, such as DS:

- The road network (Bereziuc et al, 2003) influences directly and indirectly the risks of forest fires. The forest fund of the Suceava County is lined by 56 km of national roads, 380 km of county roads, 540 km of village roads and 2435 km of forest roads. The crossing of the forests by the communication paths involves, firstly, taking the same risks in terms of fire as well as the existence of economic activity, in addition to this, the presence of the man factor has to be taken into account, the man who exploits the space, where, in the case of organized economic activities is about a stability of the staff coming into contact with the forest, while in the case of communication paths, for people transiting the forest, the variety of means of transport is given from the aim of the communication itself.

- The railway network which crosses the forest fund totals 120 km. There are both electrified railways and railways for steam or diesel locomotives. The risk of fire in the case of railways is similar to the one determined by the road means of communication, except that in the case of the railways the closing of the forest fund is more than in the case of roads, and the access of intervention special cars of fire-fighters is more difficult.

- The power lines of medium and high voltage which cross the forest fund from Suceava sum up 7968 km, of which: 2640 km of high voltage lines and 5328 km of medium voltage lines. The low voltage power lines can meet perimeter forest resources.

- The forest exploitation activity (DS; IES; Hinescu, 1978).

- The existence of economic activities in the forest – forestry, berry gathering – is driven by economic reasons. Any type of economic activity presupposes human around, the existence of different types of machinery and equipment, the use of fire in different forms. Accepting the existence of economic activities in the forest area involves also accepting risks undertaken to these activities, risks whose factors may escape, in certain circumstances, from control, resulting in fire.
- Suceava County, through the picturesque landscape, traditions and historical vestiges has developed a rich tourist activity. In this action, the forest cannot be omitted because the forest flora and fauna that it has, settled on a different terrain and lined with waters, it attracts like a magnet the tourists who are eager for beauty and rest. But all these bring an increase upon the risk of forest fire.
- The drilling wells and the exploitation of the natural gas deposits made their presence felt on the territory of Suceava County too. Of the total 35 wells at the county level, 25 wells are in the forest. The risk of fire is even greater since an incident at a gas well can lead to the escape from control of the natural gas in the atmosphere, forming pockets that can instantly light at different distances from the probe, at the first contact with an ignition source.
- The hydro technical facilities contribute to the increasing of the fire risk by their absence. Thus, given the low density of the water courses and their uneven distribution in the forest, the existence of the hydro technical facilities which provide a stable and safe water volume, would allow better organization and conduct of the intervention provided to fire operations. In this context, it has to be reminded the fact that the 48 ramps for the access and the supply of the special fire fighting vehicles, to the water courses within the forest.
- The worship buildings have usually been made in areas which allow isolation from daily worries and other temptations. Of the 558 places of worship in Suceava County, currently about 30% are located in or adjacent the forest fund. Of these, about 4% are considered isolated buildings, their access only being allowed pedestrian. The risk of fire for these buildings is not given by the intern activity, which otherwise is also a user and a generator of fire, but rather that the isolation in which they are built does not allow an immediate announcement of a fire and an appropriate action of the forces of intervention.

3. Results

In the analysed period, the evaluation of the fire for each month of the year highlights the fact that the risk of fire in the forests from Suceava is higher in spring (March, April, and May). This is largely due to the practice of cleaning the pastures and the uncut hay from the previous year, through fire, of course combined with the weather conditions during spring. When the winter “falls over spring” and there is a lot of humidity in the soil and in air, the uncut pastures/hay ignite harder, the spreading of the fire is more difficult, so the spreading to the forest is limited. Also, the dry herbaceous vegetation comes more easily, under these conditions, in the decomposition process, allowing the new sprouting of the vegetation. But, under dry conditions, the old vegetation dehydrates more, decomposes harder and in contact with the primary source of fire ignition, it is triggered very easily. This is shown in figure 2, regarding the distribution of fires on months. In analysing the risk of forest fire in Suceava, it should also be taken into consideration the psychosocial profile of the population and its economic status as the human causes of fire, caused intentionally or negligently prevail in the fire statistics in the period 1990 to 2009 (ISU ; IES).

Similarities and differences between the risk factors in the mountain forests and the lowland forests:

At a first glance, the forest fires are the same, regardless the place where they occur. But each fire, even if it is produced in the same location but in different moments, it may show ample differences of manifestation. Therefore, it is necessary to present briefly some elements of resemblance and others that differentiate the risk of forest fire from the mountain area from the ones from the lowland area, as follows:

Similarities:

- in both situations the main combustible material is composed of wood and the grass blanket;
- usually, in the forest area, the air is more oxygenated than in other areas, so the initiation of the oxidation reaction and the spreading of the fire is easily done
- the human activity is present, whether it is organized or individually.

Differences:

- the forest composition is completely different: in the mountain area are present mainly the coniferous forests, with a higher combustibility and a lower density compared to the broadleaf forests from the lowland areas.
- the topography of the mountains is more rugged and therefore the access is more difficult, with direct consequences upon the intervention actions;

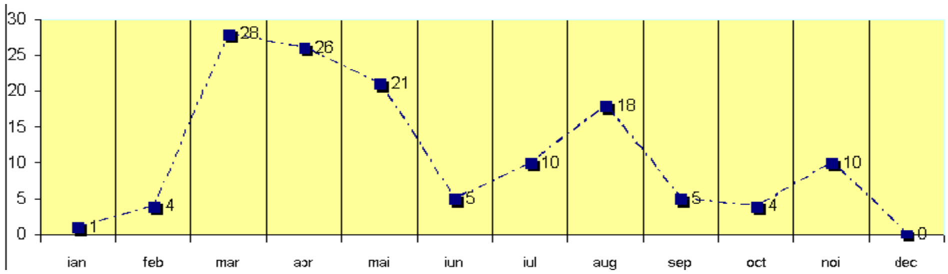

Fig. 2: The distribution of forest fires on months (1990 – 2009)

- the arrangement of the forests in the mountain area is higher than in the lowland area, where they are more isolated, which influences the spread of the fire;
- the degree of humidity is higher in the mountain areas;
- the tourist frequency is higher in the mountain area throughout the year;
- the water courses have a higher density in the mountain area, but have a lower discharge, and some exist only as torrents;
- the risk of electric discharges from the atmosphere is higher in the mountain area than in the lowland area.

4. Discussion

The temperature regime (table 1) is characterized by average values ranging from 8.0 °C in the plateau area and 0.0 °C in high mountain areas. Separately for the high mountain area, the average annual temperature values for the period 1961 / 2008, recorded at the weather stations Rarău and Călimani (INMH), present differences between the extremes: 18,66 ° C/ Rarău, respectively 15,64 °Celsius / Călimani and also the difference between the stations varies between 1 °C for the minimum and 4,02 ° C for the maximum, while the difference of altitude between a massive and the other is 447m (2100m – 1653m), thus:

The currents of air: the air masses above the county come from the west, north or east, recording some changes caused primarily because of the diversity of the landforms.

At high altitudes, the air currents have higher rates, they have higher frequencies and the effects upon the forest are more significant.

Thus, from the records from the weather stations Rarău and Călimani, during 1961/2008 (INMH), there have been calculated monthly averages (table 2).

And the same table, graphically represented, shows the influence of the altitude upon the speed of the currents of the air and also the differences recorded between the monthly extremes for the same location and different locations.

Table 1 The temperature regime - Rarău and Călimani weather station [°C]

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly average
Medium R.	-7,5	-7,6	-5,6	-0,7	4,8	8,4	10,3	10,3	5,4	2,2	-2,8	-6,5	0,9
Medium C.	-8,4	-8,8	-7,1	-2,1	4,3	7,5	9,3	9,2	4,2	1,3	-3,1	-7,1	-0,1
Maximum R.	10,0	11,0	15,7	20,2	23,8	27,0	29,0	27,2	24,8	19,8	16,5	9,7	19,56
Maximum C.	5,6	9,1	14,6	11,6	18,4	20,0	22,6	24,2	20,8	16,5	12,1	8,6	15,54

Table 2 Curent of the air speed - Rarău and Călimani weather station [m/sec]

	Jan	Febr	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Min R	1	1	2	1	2	1	1	1	1	1,4	1,5	2
Max R	5	6	5	5	4	3	4	3	4	4,6	5,7	7,3
Min C	5,7	6,3	4,8	4,6	3,8	4,7	3,5	3,7	4,6	3,7	6,8	5,8
Max C	17,9	14	12,9	11	7,7	8,3	7,6	7,2	9,3	10	12	13

Table 3 Rainfall regime - Rarău and Călimani weather station [mm]

	Jan	Febr	March	Apr	Mai	June	July	Aug	Sept	Oct	Nov	Dec
min C	5,3	3,2	11,3	17	20,6	35,8	40,5	29	21,8	1,6	15,2	7,8
max C	93,7	83,8	193,7	128,7	165,5	236,5	281,7	218,2	220,3	150,6	140,9	63,4
min R	7	3,1	5,8	22,1	31	39,5	36,5	49,4	4	4,2	6,9	10
max R	115	102,2	118,5	227,2	296,1	275,8	336,7	292,2	188,5	111,4	88,2	90

The rainfall had a very uneven pace and variation in time and space. Thus, in the high mountain forest there were significant differences of precipitation for the same period of the year (table 3).

That's why the nature and the variable influence of the rainfall regime are different upon the forest. From the multiannual records from the weather forests Călimani and Rarău (INMH), there were calculated monthly averages (maximum and minimum).

The annual average amount of precipitation ranges between 550 mm and 940 mm, depending on the height of the landform.

The initiation of a forest fire may be done due to various causes, if the conditions of the appearance of the "fire triangle" (fuel, air and ignition source) are occurred. The climatic conditions – temperature, humidity, currents of air and rainfall – have contributed as favouring factors and acted as a catalyst of the reaction of oxidation, during the production of forest fires in Suceava County.

The influence of the natural factors mentioned in table no. 1, upon the risk of forest fire is sustained by their manifestation during the production of fires in the first four forest ranges, as number of produced fires, in the period 1990-2009 [ISU "Bucovina" Suceava County, Statistical data].

In table 4 are presented the values of the climatic factors from the days of the fires in relation to the average annual values and the critical values of fire.

Table 4 Climatic factors from the days of the fires in relation to the average annual values and the critical values of fire

Nr. crt.	The indicator	Value / day / fire [8]		Average annual value [8]		Critical values of fire [2]	
		min	max	min	max	min	max
0	1	2	3	4	5	6	7
1.	temperature	5.2	32.2	5.8	13.8	17	33
2.	humidity	14	51	17	83	0	60
3.	Wind speed[m/s;km/h]	9/32.4	34/122.4	8.5/30.6		1.1/4	10.2/37

Comparatively analysing the data of table 4, columns 2 and 3 – value/day/fire with columns 6 and 7 – critical values of fire, it can be observed the fact that the values of the three indicators (maximum and minimum limits) – temperature, humidity, wind – recorded in the days when the forest fires were recorded, with the exception of the minimum limit of temperature, it goes within critical intervals, favourable to the initiation of forest fires.

In this respect, the maximum value of temperature goes to 0,8 units to the maximum limit of the critical value, at the humidity of the air the recorded values goes within the two limits (+14;-9) and the speed of the wind goes beyond the critical limits (+7,9 / 28,4;+23,8 / 85,4).

The way and the degree of the spread of a forest fire – the affected surface and the speed of the development - give its level of danger.

The spread of the forest fires is mainly determined by the influence of the natural factors, with the exception of the intentional fires of the forest.

5. Conclusion

The forest fires are clearly distinguishable from the rest of the types of fires, both in terms of initiation, observation, spread and carrying the intervention actions, but at the same time, they differ according to several parameters, including the zoning of the forest range, reported in terms of landforms, but also according to the degree of the protection of the forests from different locations.

Summarising the information presented above, we can draw the following conclusions:

- the forest fund of Romania and, implicitly, of the Suceava County, has a reduced degree of protection towards the fire, both in terms of silvicultural criteria (composition and structure, phyto-sanitary status, way and discipline in exploitation), and in terms of intervention conditions in fires (low accessibility, reduced water supplies, undersized technical equipment, compared to the level of risk) – the 17th place out of 20 from Europe;
- the climatic factors – temperature, humidity, wind – had a decisive contribution in the initiation and the

spread of fires in the forests of Suceava County (1990-2009);

- the evolution of forest fires in the period 1990 – 2009 was not uniform in time and space, and the physical and geographical characteristics of the terrain, the climatic component and the anthropogenic factor have influenced and have determined the differential of the risk of fire for the same category of forest vegetation.
- in order to compensate for the deficit of water sources, it can be chosen the realization of the motor pump relay.
- given the fact that in the period under review 74.25% of the forests were litter fires with a speed of spread of maximum 1 km / hour, 0,76% of underground fires with a speed of spread of maximum 1 km / 24 hours, we estimate the level of weather danger for Suceava forests to “moderate” (Ene, 2008).

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DS - Forestry Department of Suceava - statistical archives (1990-2009)

INMH - National Meteorological Agency of Romania, Moldova Center Iasi, statistical archives (1990-2009)

ISU - General Inspectorate for Emergency Situations – statistical archives

IES - Inspectorate for Emergency Situations "Bucovina" of Suceava County – statistical archives (1990-2009)

ISU - General Inspectorate for Emergency Situations, The research methodology in establishing the causes of fire, (internal use), 2010

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Aspects regarding the red deer trophy size (*Cervus elaphus* l.) in the beech – fir tree mixture areas in comparison with those in the spruce- fir tree areas

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Abstract. The research aims at the analysis of some correlations between the ecological conditions of the hunting ground (altitude, slope, vegetation duration, medium thickness and duration of the snow layer etc.), and the red-deer trophy size in Suceava district. The study relies on the comparison between the trophies harvested on the hunting grounds in the beech and fir-tree forests (about 700 m medium altitude) and those harvested in the spruce fir-forests (about 1000-1100 medium altitude). In this respect, we take into account the red-deer trophies harvested in the water shed of Suha and Rasca rivers (the North of the Stanisoara mountains) in comparison with the trophies harvested in the superior water shed of Moldova (Rarau-Giumalau massif) and in the water shed of Dornelor. When characterizing the red-deer trophies, we consider over the length and circumference of the beams, the weight and also the eye guard-point length, the middle-point length and the number and length of the palmed antlers. In some cases, if necessary, we also take into account the ice-points.

Keywords: red-deer, trophy, ecological condition

1. Introduction

The present analysis aimed to establish certain differences between the trophy size at the red deer which live in different forest eco-systems (mixtures of beech-resinous forests and pure spruce-fir forests). The causes of these differences may be: food abundance and the duration of vegetation period, which are superior in the beech-resinous forests. Moreover, in the pure spruce-fir areas, the hard winters may lead to a higher consumption of energy, fact which can negatively affect the size of the trophy (Cotta, 2001).

2. Material and method

The essential data was taken from the administrators of the respective hunting territories: Forest Department Suceava, District Association of Hunters Suceava and "Stefan cel Mare" University Suceava.

The research focused on the hunting territories in Suceava district, where there are mixtures of beech fir tree areas and spruce-fir tree areas. Thus, the red deer trophies which were analysed came from Bogdănești, Râșca, Marginea and Solca, C-lung Moldovenesc, Broșteni, Iacobeni, Dorna Arini and Panaci.

The trophies that were chosen were those with a C.I.C. score of 170-210 points and the criteria of choosing avoided the trophies with very high scores or those which had missing parts (broken antlers, incomplete upper maxilla etc.) (Neacsu, 1982, Șelaru, 2000).

Thus, 68 trophies were identified, out of which 34 from the beech-resinous tree mixture area and 34 from the spruce-fir tree area. Individual measurements were done on the trophies which did not have the evaluation card. In order to characterize the red deer trophy size, the following measurements were done: length and circumference of antlers, weight, length of eye guard, middle points and the number of points. The basic data are then analyzed.

The means of measured values of each element were calculated for each sample of 34 trophies; the partial score C.I.C. was calculated taking into account only the measurements (without additions). The statistical test *Fisher* and the *Student* test were done comparing the statistical chains of each measured element. When, were done three classes of trophy sizes depending on the partial C.I.C. score (without addition).

3. Results

In the table 1 there are presented the medium values of the measurable elements for the two samples of red-deer trophies. For each one can notice the higher value of the mean for the-red deer harvested from the mixtures of beech-resinous tree forests.

Table 1. Measurable Elements of the Red-Deer Trophy (fig.1)

Nr. crt.	Harvesting Area	Measurable Elements of the Red-Deer Trophy								
		Partial Score	Antler Length (cm)	Eyeguard Point Length (cm)	Middle-point Length (cm)	Antler circumference between eyeguard point and middle point (cm)	Antler circumference between middle point and crown (cm)	Weight (kg)	Number of Points	Proportion between length and medium circumference of antlers
1	Mixtures	144,43	115,75	44,00	40,00	15,85	15,50	9,10	16,00	7,38
2	Mixtures	144,20	115,00	45,25	40,95	17,35	16,20	9,30	13,00	6,86
3	Mixtures	143,30	116,25	35,50	36,00	17,20	16,70	10,20	13,00	6,86
4	Mixtures	140,69	114,50	39,00	44,75	18,00	15,50	8,50	12,00	6,84
5	Mixtures	139,08	111,00	32,75	48,75	16,15	16,45	8,30	14,00	6,81
6	Mixtures	138,51	110,00	37,50	32,75	15,50	14,85	8,80	18,00	7,25
7	Mixtures	136,73	103,00	37,00	51,50	17,50	15,60	8,00	14,00	6,22
8	Mixtures	136,01	97,75	42,00	49,35	16,00	14,50	7,90	18,00	6,41
9	Mixtures	134,69	105,00	40,25	35,90	16,70	15,45	7,50	16,00	6,53
10	Mixtures	134,49	112,25	29,80	29,45	17,65	14,50	8,20	15,00	6,98
11	Mixtures	134,35	112,25	37,50	27,00	15,50	14,20	7,20	18,00	7,56

Nr. crt.	Harvesting Area	Measurable Elements of the Red-Deer Trophy								
		Partial Score	Antler Length (cm)	Eyeguard Point Length (cm)	Middle-point Length (cm)	Antler circumference between eyeguard point and middle point (cm)	Antler circumference between middle point and crown (cm)	Weight (kg)	Number of Points	Proportion between length and medium circumference of antlers
12	Mixtures	132,90	114,50	31,90	37,90	14,40	13,40	7,20	16,00	8,24
13	Mixtures	132,85	110,50	45,90	31,50	15,25	14,20	8,40	12,00	7,50
14	Mixtures	131,44	105,20	38,90	38,25	14,90	13,45	8,10	15,00	7,42
15	Mixtures	131,20	110,75	37,60	37,30	14,20	13,70	8,10	13,00	7,94
16	Mixtures	129,70	97,20	37,70	41,50	15,30	14,00	8,00	16,00	6,63
17	Mixtures	128,50	97,20	37,70	41,50	15,50	14,00	7,30	16,00	6,59
18	Mixtures	127,78	95,25	38,85	38,95	16,50	16,20	6,50	15,00	5,83
19	Mixtures	127,60	105,00	34,50	46,50	14,40	13,85	6,80	13,00	7,43
20	Mixtures	126,50	102,00	38,00	32,80	14,75	12,65	7,70	15,00	7,45
21	Mixtures	125,79	105,00	30,25	34,50	14,00	13,50	7,80	14,00	7,64
22	Mixtures	125,35	99,90	39,70	41,90	13,70	13,90	6,70	14,00	7,24
23	Mixtures	123,71	106,00	36,00	26,65	14,65	14,20	7,10	12,00	7,35
24	Mixtures	122,86	100,25	39,75	34,00	13,90	13,60	6,90	13,00	7,29
25	Mixtures	122,60	100,00	35,30	27,10	15,60	14,60	7,40	12,00	6,62
26	Mixtures	120,75	103,50	38,50	29,50	14,00	13,60	5,70	13,00	7,50
27	Mixtures	120,44	93,50	32,75	33,00	13,90	14,95	7,20	14,00	6,48
28	Mixtures	115,30	93,00	31,50	28,50	14,00	14,00	6,40	13,00	6,64
29	Mixtures	115,02	99,88	31,60	28,70	14,20	12,40	6,70	10,00	7,51
30	Mixtures	114,35	100,40	31,75	24,05	14,00	12,80	6,20	11,00	7,49
31	Mixtures	112,65	97,00	37,00	22,00	13,00	12,00	8,20	8,00	7,76
32	Mixtures	112,20	94,45	39,50	24,00	16,65	12,45	5,50	9,00	6,49
33	Mixtures	105,60	97,20	29,60	14,00	12,90	12,80	5,20	10,00	7,56
34	Mixtures	103,80	95,00	27,50	26,50	12,50	10,50	4,90	10,00	8,26
	Average	**114,09**	**93,04**	**32,69**	**30,97**	**13,57**	**12,64**	**6,66**	**12,13**	**7,10**
1	Pure spruce	142,45	115,25	44,05	30,05	16,25	16,25	7,90	18,00	7,09
2	Pure spruce	142,09	114,50	39,00	44,75	18,00	15,50	9,20	12,00	6,84
3	Pure spruce	138,25	112,70	36,35	35,65	16,35	14,75	8,90	15,00	7,25
4	Pure spruce	134,18	110,00	41,85	36,85	17,25	15,05	8,60	10,00	6,81
5	Pure spruce	132,36	100,70	38,95	37,90	16,50	16,30	7,50	15,00	6,14
6	Pure spruce	132,15	101,60	46,45	35,55	15,75	14,50	8,30	14,00	6,72
7	Pure spruce	130,15	101,30	25,80	32,00	17,25	17,00	7,90	15,00	5,92
8	Pure spruce	129,70	97,20	37,70	41,50	15,30	14,00	8,00	16,00	6,63
9	Pure spruce	128,95	105,70	34,95	29,25	14,15	13,50	7,70	17,00	7,65
10	Pure spruce	128,95	108,50	33,00	27,00	16,25	14,25	7,10	15,00	7,11

Nr. crt.	Harvesting Area	Measurable Elements of the Red-Deer Trophy								
		Partial Score	Antler Length (cm)	Eyeguard Point Length (cm)	Middle-point Length (cm)	Antler circumference between eyeguard point and middle point (cm)	Antler circumference between middle point and crown (cm)	Weight (kg)	Number of Points	Proportion between length and medium circumference of antlers
11	Pure spruce	125,86	105,30	34,60	33,05	15,60	14,50	7,10	12,00	7,00
12	Pure spruce	125,41	107,30	42,35	32,10	16,00	13,75	6,70	10,00	7,21
13	Pure spruce	125,31	108,90	21,65	30,60	15,50	15,30	7,50	12,00	7,07
14	Pure spruce	122,31	97,75	30,75	38,00	15,50	13,75	7,00	13,00	6,68
15	Pure spruce	121,20	100,50	32,50	23,50	15,00	13,75	7,10	14,00	6,99
16	Pure spruce	120,85	106,25	36,05	33,65	13,45	13,85	6,00	11,00	7,78
17	Pure spruce	120,05	102,95	32,20	23,90	14,75	13,00	6,90	13,00	7,42
18	Pure spruce	119,48	95,25	37,05	33,75	14,25	13,50	7,70	11,00	6,86
19	Pure spruce	118,58	88,50	38,40	36,30	15,80	14,25	6,30	13,00	5,89
20	Pure spruce	118,53	95,00	37,00	32,50	14,75	13,50	6,20	13,00	6,73
21	Pure spruce	118,03	94,70	36,00	29,90	15,40	14,20	6,30	12,00	6,40
22	Pure spruce	117,70	102,30	30,70	26,50	14,55	13,50	6,10	12,00	7,29
23	Pure spruce	116,78	93,00	33,00	21,50	16,50	16,55	6,30	11,00	5,63
24	Pure spruce	116,74	101,75	31,00	27,25	14,60	13,50	5,60	12,00	7,24
25	Pure spruce	116,12	96,50	35,80	27,25	14,95	12,10	6,03	13,00	7,13
26	Pure spruce	116,10	102,00	21,50	29,50	14,50	13,25	6,80	11,00	7,35
27	Pure spruce	114,68	92,00	34,50	29,00	16,00	14,00	6,90	9,00	6,13
28	Pure spruce	114,51	93,30	29,25	36,40	14,75	12,50	6,10	12,00	6,85
29	Pure spruce	113,14	92,60	36,85	28,50	14,00	13,50	6,00	11,00	6,73
30	Pure spruce	112,95	94,50	34,75	27,25	14,25	12,75	6,10	11,00	7,00
31	Pure spruce	111,28	93,10	31,70	32,60	14,50	13,15	4,00	13,00	6,73
32	Pure spruce	110,74	76,20	35,25	32,50	14,50	14,20	6,00	15,00	5,31
33	Pure spruce	106,25	83,50	39,00	29,00	13,00	11,50	5,50	12,00	6,82
34	Pure spruce	105,01	89,40	34,20	20,05	14,10	13,25	5,20	9,00	6,54
	Average	**109,13**	**88,95**	**31,16**	**28,03**	**13,66**	**12,58**	**6,12**	**11,37**	**6,78**

After applying the Fisher test, the Student (table 2) test was applied and, at 4 of the 7 measured elements, a significant difference was noticed.

At some elements of the trophy, which have a major influence on the final score, a significant difference between the means of the two samples can be remarked.

It is obvious that the antler circumference is not significantly different, as the size difference comes from the difference of some elements length and of weight and points number.

The proportion between the medium length of the antlers and the medium circumference was also done; the medium values of this indicator show a higher “slimness index” for the trophies harvested in the beech tree mixtures. Basically, the antlers are longer at the same value of the antler section.

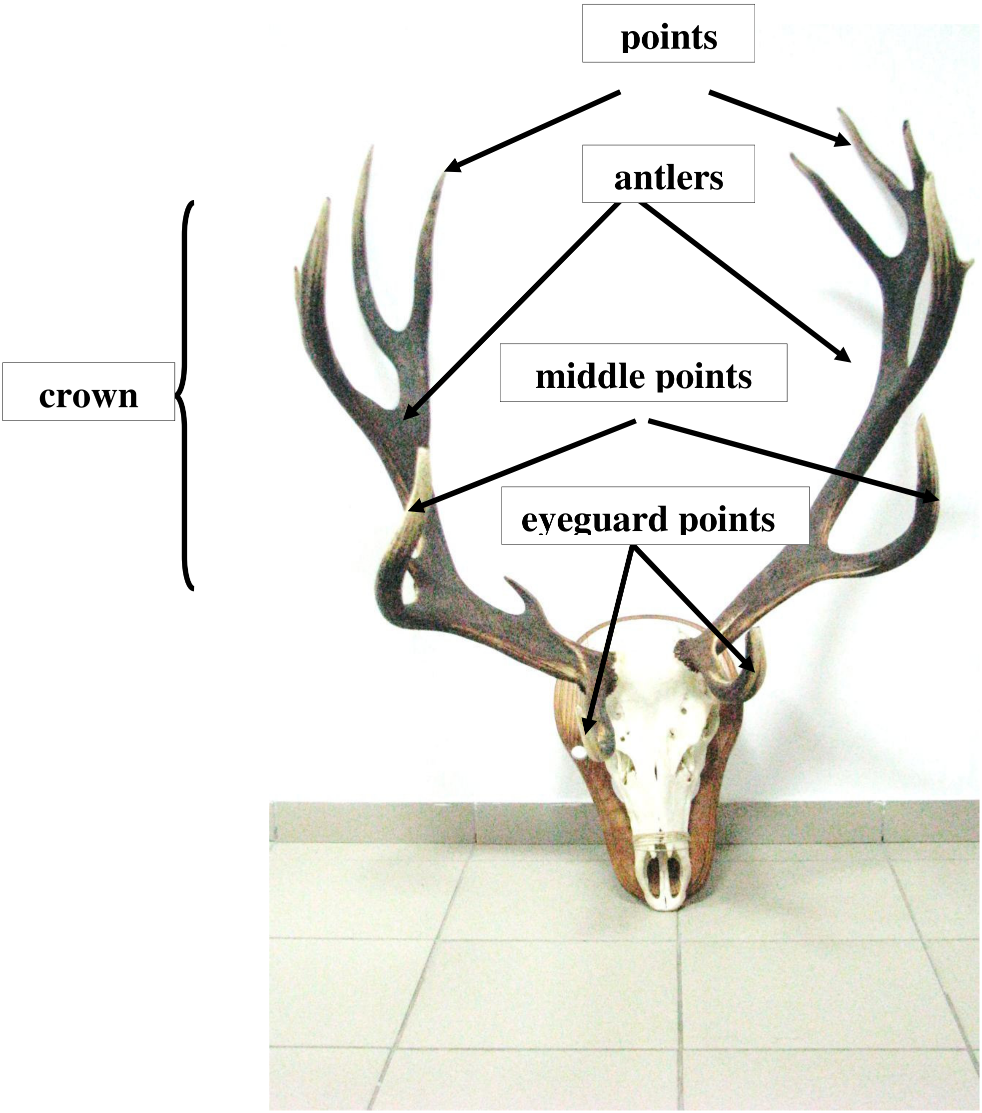

Figure 1. Measurable Elements of the Red-Deer Trophy

Table 2. The *student* test for the value chains

The *student* test for the value chains of each measurable element									
Measured elements	**Partial score**	**Antler length (cm)**	**Eyeguard point length (cm)**	**Middle-point length (cm)**	**Antler circumference between eyeguard point and middle point (cm)**	**Antler circumference between middle point and crown (cm)**	**Weight (kg)**	**Number of points**	**Proportion between length and medium circumference of antlers**
T statistic	**2,372**	**2,465**	1,489	**1,735**	-0,306	0,264	**2,090**	**1,700**	**2,451**
T critic	1,669	1,669	1,669	1,669	1,669	1,669	1,669	1,669	1,669

Table 3. The means of the partial scores

Class	Class size (CIC points)	Sample Mixture	Sample Pure Spruce
1	130-150	136,99	135,95
2	120-130	125,13	124,86
3	100-120	111,27	114,51

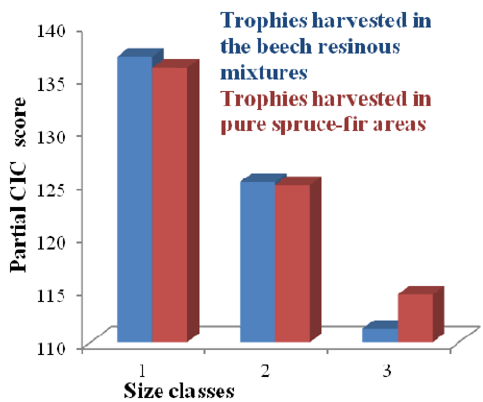

Figure 2. Means of the partial scores

The chosen trophy samples were split in three size classes (table 3, fig. 2), for each sample and for each class, the means of the partial scores being calculated according to C.I.C.

A higher score can be noticed on the red-deer trophies from the mixtures in the case of the two superior classes (1 and 2). The lower-scored trophies – class 3, had a higher mean in spruce-fir tree areas. It is a well known fact that the superior scores belong to the fully developed red-deer at the age of 9-11 years. Thus, we can presume that the trophies belonging to class 1 and 2 had more bone layers in the areas which were more climatically favorable.

Another reason of this difference can be the small number of trophies with partial scores, bellow 120 C.I.C. pct, as a result of the choosing methodology of the sample.

4. Conclusions

As a result of the statistical tests done on the analysis samples, one may conclude that:

- Favorable environmental conditions lead mainly to the development of the antlers in length;
- At the equivalent weight of the trophy, in the area with more favorable ecological conditions, the antler develops a richer crown regarding the number of points;
- On the trophies harvested in the spruce-fir tree area, the antlers are thicker in the first half (between the eye guard point and the middle point) and the number of points is smaller.

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Jugglers in statistics of normality

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Abstract: The starting point of any statistical analysis of natural phenomena is the normality test. Before finding out which predominant factor alters the normality of the experimental distribution, it is necessary to pass through a goodness-of-fit test stage for the theoretical distribution. This paper initiates a discussion on the precision of the classical adjustment process, which requires preserving the same experimental values of the mean and the variance (or standard deviation) for the theoretical distribution produced after fitting. The method is demonstrated on 101 samples of diameter at breast height (dbh), with 139 values each. The samples were randomly selected from a normal population with 1383 statistical units. The proposed optimization method of successive iterations in Excel starts with the mean and the standard deviation of the experimental distribution and makes possible a better fitting (minimizing the sum of the squared deviations) with a theoretical normal distribution for which the average and standard deviation are barely modified.

Keywords: normal distribution, normality, goodness-of-fit, squared deviations

1. Introduction

Fitting the experimental distributions is one of the practical problems any statisticians is facing with when analyzing different phenomena in forestry. The normal distribution characterizes a wide range of natural phenomena that are influenced by a number of factors acting simultaneously with approximately the same intensity.

In most of the cases, due to limited technical and economic possibilities to measure and record large samples, some low-volume samples taken from the whole population are enough for performing different tests. This analysis relies on a selective extraction of units that have been priory randomly extracted from the entire population. After having calculated the statistical parameters of the sample, these statistics are extrapolated to the initial population taking into account the specific confidence intervals.

For instance, the arithmetic mean ($\overline{x}$) and standard deviation (s) estimated for a sample with volume $\boldsymbol{n}$ will therefore represent estimations for mean (μ) and standard deviation (σ) corresponding to the whole population with a much higher volume $\boldsymbol{N} \gg \boldsymbol{n}$.

If one intends to check the normality of experimental distribution, the above-mentioned indicators are specific parameters of theoretical normal distribution appropriate to experimental values of the analyzed characteristic (Horodnic, 2004).

Therefore normality analysis consists of establishing the level of adjustment ("goodness of fit") for an experimental distribution using theoretical normal distribution.

The vast majority of the fitting procedures are based on the mandatory condition that the theoretical distribution parameters should be strictly equal with the parameters of experimental distribution (in this case, $\bar{x}$ and s) and subsequent calculation of the theoretical values of probability density function, according to these statistical indicators (Dodge, 1993; Giurgiu, 1979; Țarcă, 1998).

2. Proposed method

Since $\bar{x}$ and s depend on the selection process and have equal values with those of the whole population only by chance, the method that we propose herein considers the possibility to optimize their values for the best fitting.

The "juggling" consist of an iterative algorithm in Excel that uses, at each step, a modified pair of values $\bar{x}$ and s, starting with the experimentally determined values for the sample and resuming each new iteration with the values resulted in the previous step. The optimization criterion is minimizing the sum of squared deviations (SSD) of experimental absolutes frequencies against those corresponding to theoretical normal function calculated at each step.

The samples were randomly selected from a normal population with 1383 statistical units (*figure 1*).

As mentioned before, 101 samples for *diameter at breast height (dbh)* characteristic, with 139 values each, were analyzed.

The proposed method of successive iterations in Excel (*figure 2*) modifies the mean and the standard deviation obtained for the experimental distribution and makes possible a better fitting with theoretical normal distribution.

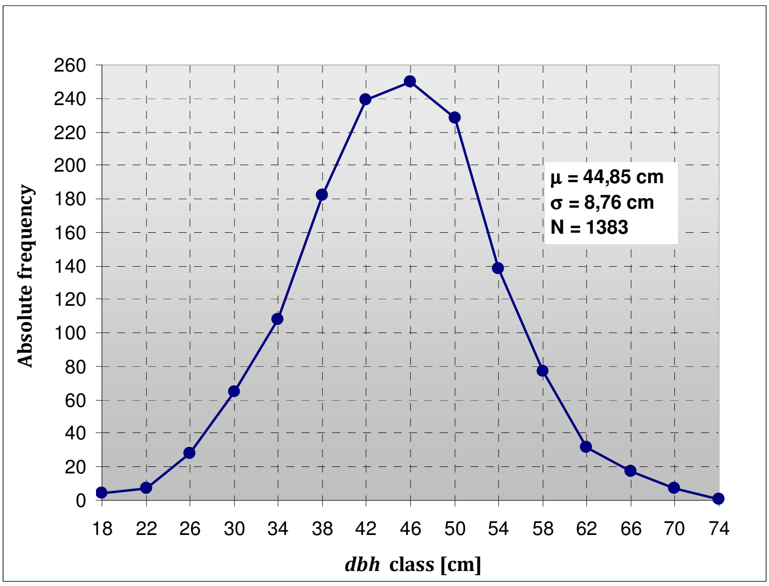
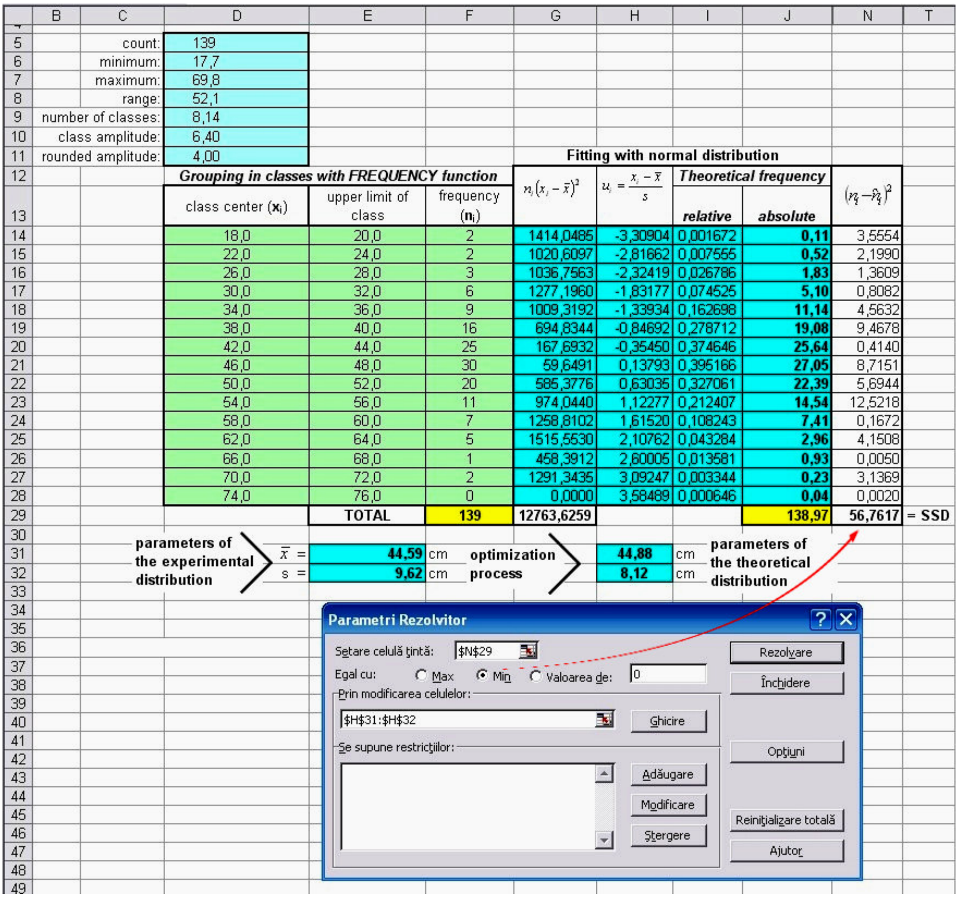


Figure 1. The experimental distribution of *dbh* in the studied population



count:	139
minimum:	17,7
maximum:	69,8
range:	52,1
number of classes:	8,14
class amplitude:	6,40
rounded amplitude:	4,00

Grouping in classes with FREQUENCY function			Fitting with normal distribution		Theoretical frequency		
class center (x_i)	upper limit of class	frequency (n_i)	$n_i(x_i-\bar{x})^2$	$u_i=\frac{x_i-\bar{x}}{s}$	relative	absolute	$(n_i-\hat{n}_i)^2$
18,0	20,0	2	1414,0485	-3,30904	0,001672	**0,11**	3,5554
22,0	24,0	2	1020,6097	-2,81662	0,007555	**0,52**	2,1990
26,0	28,0	3	1036,7563	-2,32419	0,026786	**1,83**	1,3609
30,0	32,0	6	1277,1960	-1,83177	0,074525	**5,10**	0,8082
34,0	36,0	9	1009,3192	-1,33934	0,162698	**11,14**	4,5632
38,0	40,0	16	694,8344	-0,84692	0,278712	**19,08**	9,4678
42,0	44,0	25	167,6932	-0,35450	0,374646	**25,64**	0,4140
46,0	48,0	30	59,6491	0,13793	0,395166	**27,05**	8,7151
50,0	52,0	20	585,3776	0,63035	0,327061	**22,39**	5,6944
54,0	56,0	11	974,0440	1,12277	0,212407	**14,54**	12,5218
58,0	60,0	7	1258,8102	1,61520	0,108243	**7,41**	0,1672
62,0	64,0	5	1515,5530	2,10762	0,043284	**2,96**	4,1508
66,0	68,0	1	458,3912	2,60005	0,013581	**0,93**	0,0050
70,0	72,0	2	1291,3435	3,09247	0,003344	**0,23**	3,1369
74,0	76,0	0	0,0000	3,58489	0,000646	**0,04**	0,0020
	TOTAL	139	12763,6259			138,97	56,7617 = SSD

Figure 2. Using Solver tool in Excel for minimizing the sum of the squared deviations

After grouping the observations into classes using the FREQUENCY function (Horodnic, 2008), the classical adjustment method was used to produce a set of theoretical values for frequencies of the normal function, thus obtaining the *SSDinitial*. Further, the Solver tool was used to minimize the SSD, and the *SSDfinal* is being computed and corresponds to the set of normal theoretical frequencies.

For example, it is shown in *figure 3* the outcome of the common adjustment method carried out on a sample, while *figure 4*, presents the outcome of using the new method, which minimizes the SSD.

A simple visual analysis reveals a better accuracy of fitting, especially in the area of higher experimental frequencies (corresponding to the central area of the distribution), which is more important, in fact, for a fair interpretation of the studied phenomenon.

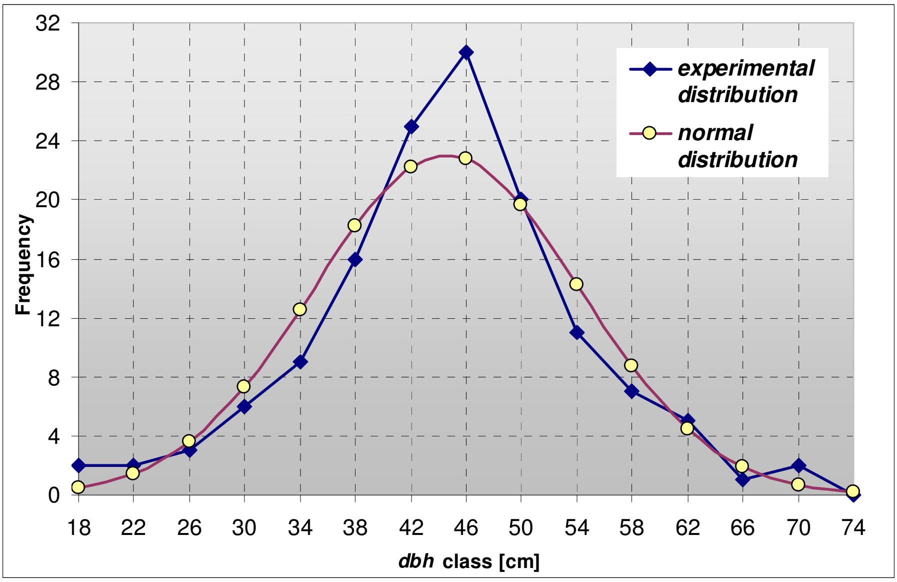


Figure 3. Example of applying the classical method of adjusting for sample no.62

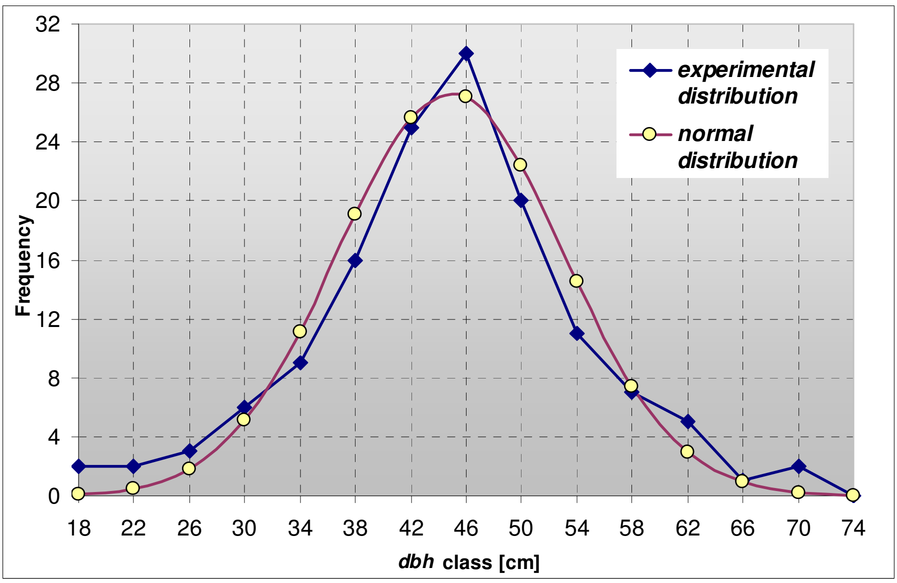


Figure 4. Example of applying the proposed method of adjusting for sample no.62

3. Results and discussion

As shown in *figure 2*, the new method does not alter the initial values of the sample. It starts with the mean and the standard deviation of the experimental distribution and makes possible a better fitting (minimizing the sum of the squared deviations) with a theoretical normal distribution for which the average and standard deviation are barely modified.

The first discussion is focused on the SSD values produced by the proposed method (*SSDfinal*) compared with those obtained by the conventional fitting method (*SSDinitial*). *Figure 5* shows a clear displacement of high SSD values from the right-hand half of the SSD distribution to the left-hand half, which emphasizes a significantly better adjustment produced by the method we have proposed.

Analyzing the standard deviations of all 101 samples one may see an increasing tendency of this statistical indicator produced by the classical fitting method, compared to σ.

Theoretical values of s are, in fact, equal with the experimental ones and fall into the class ranges from 7.8 cm to 10.2 cm (*figure 6*). The situation is different (*figure 7*) when it comes to the values of standard deviations s provided by method we propose herein: on average, they are smaller than σ and are framed within a range slightly more extended to small values (from 7.0 cm to 10.2 cm).

Regarding the average of means ($\bar{\bar{x}}$), it is smaller than μ in both situations (*figure 8* and *figure 9*); the proposed method produces means of samples after adjustment that fall into a wider range (42.2 cm to 47.0 cm) compared to the experimental ones (42.8 cm to 46.4 cm).

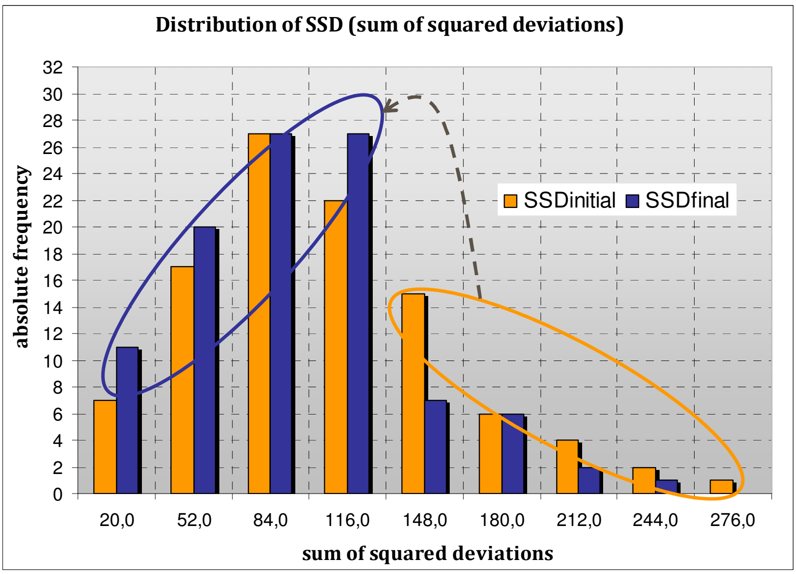


Figure 5. Distribution of SSD values achieved by the proposed method (SSDfinal) compared with those obtained by classical fitting (SSDinitial)

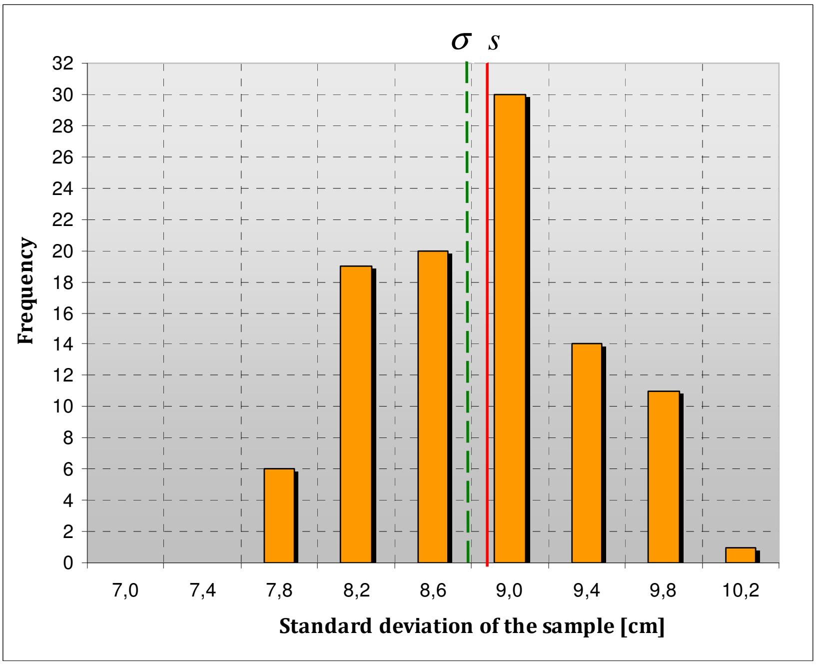


Figure 6. Distribution of standard deviations obtained for normal function by classical fitting

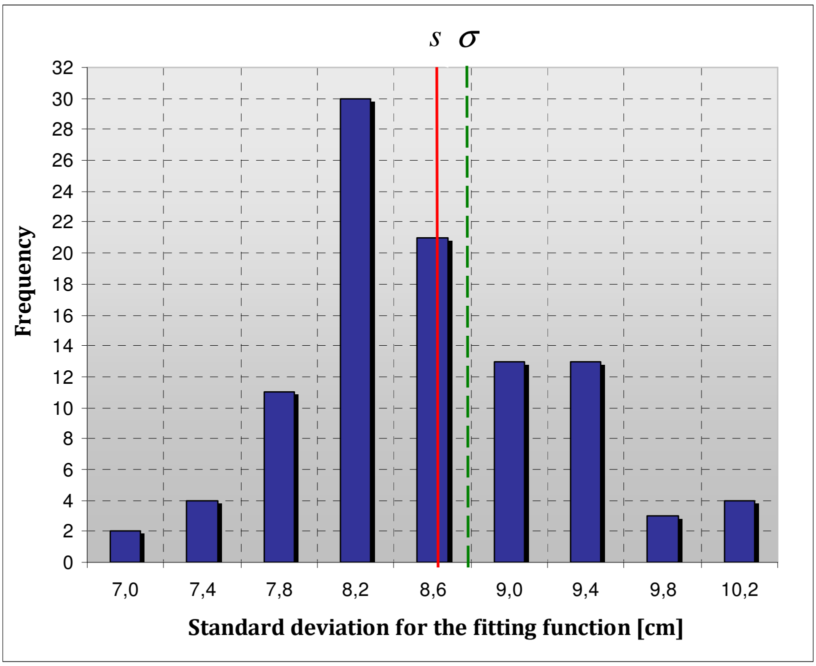


Figure 7. Distribution of standard deviations obtained for normal fitting function by minimization of SSD (sum of squared deviations)

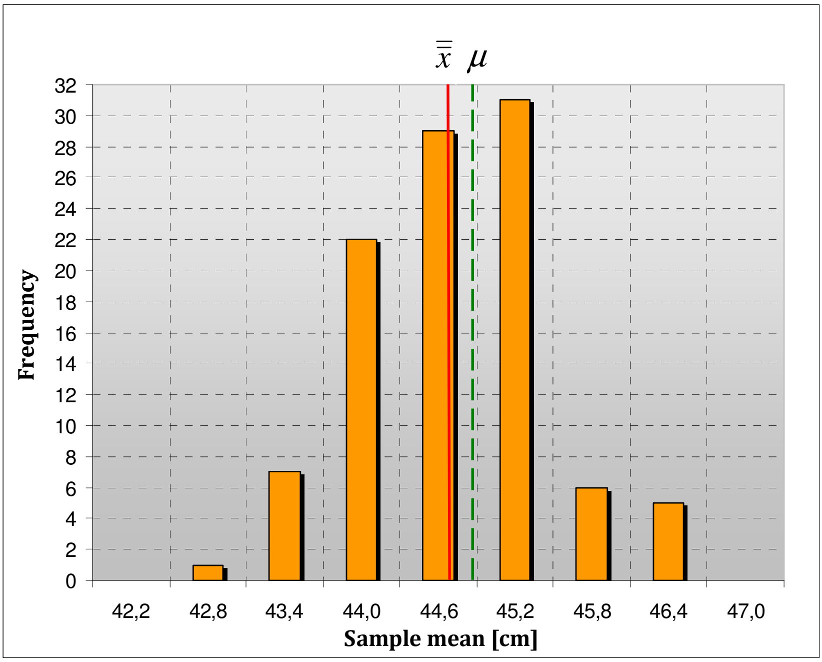


Figure 8. Distribution of sample means obtained by classical fitting

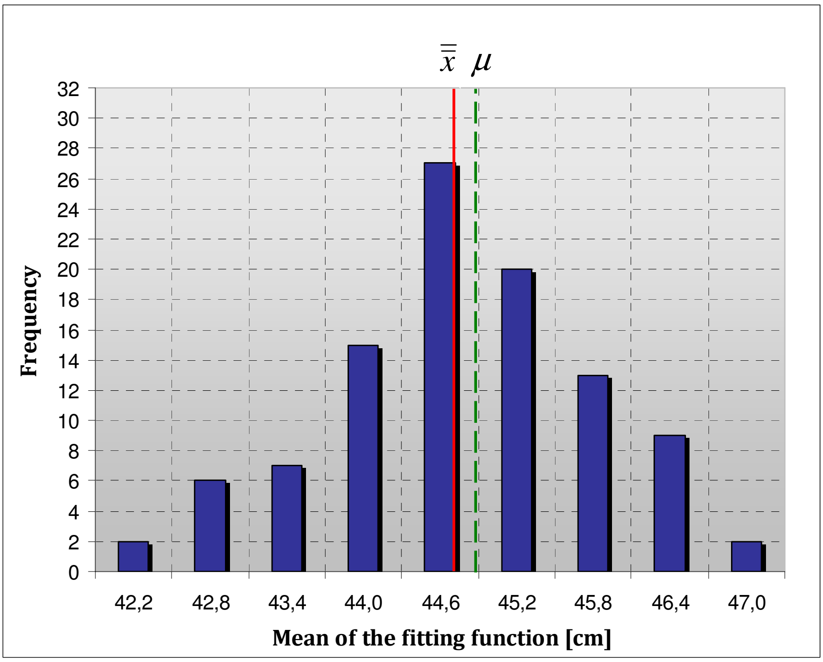


Figure 9. Distribution of means obtained for normal fitting function by minimization of SSD

4. Conclusions

The advantages of applying the adjustment method we proposed herein are two: on the one hand, it minimizes the sum of squared deviations and on the other hand it decreases the risk of rejecting the normality assumption for distributions where the result of classical adjustment process is, at limit, not statistically significant.

Precautions are needed in conducting the surveys in order to prevent large differences between the parameters of the experimental and theoretical distributions. Thus, it is recommended to use a sampling rate of at least 10% of the entire population and attention must be paid to the experimental distributions with high levels of standard deviation by checking their homogeneities in advance, having in mind that any coefficient of variation shall be smaller or equal to 30%.

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Restoration Management in Small Forest Watersheds

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Abstract: The measures whose aim is to secure functionally integrated forest management should be suggested within the restoration management of small forest watersheds. In addition to the design of concrete compensation measures, preventive interventions should be established in forest watersheds, too. The forest watersheds restoration management should reflect the expected impacts and influences of suggested measures on the water regime of forest watersheds. The paper deals with the possibility to suggest the concrete compensation and preventive measures on the bases of classification of forest watersheds into the so-called efficiency classes. An efficiency class reflects the degree of anthropogenic influence on water regime of forest watersheds. The evaluation of the above mentioned degree is based on the analysis of forest watershed individual components – the state of forest stands, forest roads network, concentrated runoff paths and forest soil. The determination of the resulting efficiency class is based on the combination of selected criteria. These are as follows: a) real effect of hydric-water-management forest function combined with anthropic-conditioned functional effectiveness degree, b) density and state of forest haul roads, c) the skidding roads and trails state in the watershed, d) water recipients state, e) concentration runoff paths occurrence, f) depth of watershed runoff. The relevancy for particular criteria was said according to the fact how the criterion affects the forest watershed water regime. The forest watershed efficiency class is given by combining the criteria and their relevancy. The first efficiency class represents the forest watershed with stable water regime without negative human interventions. The second efficiency class represents the forest watersheds with partially negatively influenced water regime by anthropogenic activity. The third efficiency class includes unstable watersheds with serious water regime disturbance. The specific measures of preventive and compensatory character are subsequently defined for each efficiency class, and the required direction of watershed individual components development is determined.

Keywords: forest ecosystem, hydric-water management function, forest watershed water regime, negative human interventions

1. Introduction

Forest ecosystems affect the landscape hydric regime by two basic ways. Forests take directly part in landscape water balance and affect the soil profile significantly. Effects of forest ecosystems on the water regime are researched in detail since the early 20th century. One of the classic work which deals with the effects of forest on hydric regime is the study of Engler (1919). The water regime and runoff process in not fully forested and forested small watershed in Switzerland are compared. Krutsch (in Delfs 1958) accomplished systematic measurements of some items of the forest water regime in Tharandt (German) already in 1863. There are many results of scientific studies which confirm the indisputable and unquestionable positive impact of the forests on the hydrological regime. Among the most important information resources can be included works such as Hewlett (1986), Maidment (1993), Beven (2002), Chang (2006), or bedient Huber, Viex (2007). The works of the authors Biba et al. (2001); Chlebek and Jařabáč (1998); Chlebek et al. (1997) and comprehensive study Kantor et al. (2003) dealt with the influence of forest vegetation cover on runoff conditions in the Czech Republic. The influence of forests and vegetation cover on runoff is also solved in the infiltration methods of rainfall-runoff models - SCS/CN (Soil conservation service curve number).

To support or restore of a balanced hydric regime of anthropogenic influenced forest watersheds the purposeful and graduated restoration management is used. This restoration management is based on analyses of individual watershed compoments and their influence on rainfall-runoff process. The determinantion of the clearly defined objectives is a prerequisite for feasible project of graduated restoration management of forest watersheds. The degree of anthropogenic influence on water regime of forest watersheds must be determined. A part of the restoration management project should also be methods for an assessment of proposal measures impacts to verify the achievement of restoration management objectives. The paper deals with one possibility how to determine the degree of anthropogenic influence on water regime of forest watersheds.

2. Materials and methods

The degree of anthropogenic influence on water regime of forest watersheds and the forest watershed efficiency class determination is based on analyses and synthesis of gained data.

Forest watershed efficiency classes (marked I, II and III) are proposed according to their funcionallity and the evaluated influence on runoff. This efficiency classed reflect the degree of antropogenic influence on water regime.

The efficiency class I is defined for forest watersheds – stable, undamaged; the class II includes watesheds within partially damaged water regime (partially stable) and the class III represents heavily disturbed (unstable) watersheds by human activities.

The analysis is based on detailed description of individual watershed parts. These individual parts are following:

- Forest stands state
- Quantification of hydric water-management functions and selected functional linkages in forest watershed. The real effect of hydric water-management function is evaluated according to the method "Quantification and Evaluation of Forest Functions on the Example of the Czech Republic" (Vyskot et al. 2003). The real effect of forest function

(RE_{FF}) is expressed as a percentage of real potencial of forest function (RE_{FF} = % of RP_{FF}). RP_{FF} is defined as quantified values of produced functions under optimum ecosystem conditions and RE_{FF} represents quantified values of produced functions under topical ecosystem conditions. The determination of the differences between the real potentials of forest functions and the current and natural species composition of forest stands is solved by a method "Anthropic-conditional functional effectiveness scale" (Schneider et al. 2009).

- Soil conditions and the type of soil water regime (according to method by Macků (Macků 2000).
- Forest road network
- Drainage of concentrated runoff
- Determination of the direct runoff volume.
- The modification of runoff curve number method (according to Macků 2000) was chosen for evaluation of retention ability of forest soils. This modification uses a derivation of runoff curve numbers from available characteristics according to Czech forest typology.
- The evaluation of forest soils erosion (according to a method Macků 2008).

A detailed description of the analytical methods is beyond the scope of this paper and is available on request at the authors of this paper. The synthesis and the resulting classification of forest watershed in the efficiency class are included in the next chapter.

3. Results

The classification of forest watershed in the efficiency class is a prerequisite for the proposal and project of restoration management. The basic criteria according to which can be classified a evaluated forest watershed into the degree of anthropic influence on water regime in the following subsections are summarized.

The real effect of hydric water-management function (RE_{HV}) combined with the anthropic-conditional functional effectiveness degree (ACFE degree) (code RExA):

The value of the total RE_{HV} for component classification of forest watershed is used. The principle of forest watershed classification into the efficiency class according to the total RE_{HV} is following:

Efficiency class I – weighted arithmetic mean $ØRE_{HV}$ over 75 % of $ØRP_{HV}$ ($ØRE_{HV} \geq 75\%\ ØRP_{HV}$) – code A;

Efficiency class II - weighted arithmetic mean $ØRE_{HV}$ between 50 and 75 % of $ØRP_{HV}$ ($50\ \%\ ØRP_{HV} \leq ØRE_{HV} \leq 75\ \%\ ØRP_{HV}$) - code B;

Efficiency class III - weighted arithmetic mean $ØRE_{HV}$ less than 50 % of $ØRP_{HV}$ ($ØRE_{HV} \leq 50\ \%\ ØRP_{HV}$) - code C.

The forest watershed is classified into the efficiency class according to the ACFE degree as follows:

Efficiency class I – degree 2 predominates on the watershed area ($-1 \leq \Delta\sum RP_{FF} \leq 1$) – code 2;

Efficiency class II – degree 3 predominates on the watershed area ($\Delta\sum RPff \geq -2$) – code 3

Efficiency class III – degree 1 predominates on the watershed area ($\Delta\sum RPff \geq 2$) – code 1.

The combination to determine the efficiency class according to RE_{HV} and ACFE degree is shown in Table 1.

Table 1 The combination of anthropic-conditional functional effectiveness degree and the real effect of hydric-water management function (Kozumplíková 2010)

ACFE degree	RE_{HV}	Efficiency Class
1	A	II
1	B	III
1	C	III
2	A	I
2	B	I
2	C	II
3	A	I
3	B	II
3	C	III

The density and state of forest road network (code FR)

The density and state of forest haul roads and the state of skidding roads and trails further the degree of the threat of forest soils by water erosion and the resistance of forest soil to the logging-transport erosion.

Efficiency class I – the real density of forest haul roads up to 100 % of optimal density;

Efficiency class II – the real density of forest haul roads over 100 % of optimal density on soils with the mean to extraordinary resistance degree of resistance to the logging-transport erosion on 75 % of watershed area;

Efficiency class III – the real density of forest haul roads over 100 % of optimal density on soils with the low to very low resistance degree of resistance to the logging-transport erosion on 75 % of watershed area.

The state of skidding roads and trails (ST):

Efficiency class I – more than 75 % of skidding roads and trails without damage on bearable soils (resistance is from mean to extraordinary);

Efficiency class II – less than 75 % of skidding roads and trails with damage on bearable soils (resistance is mean to extraordinary) or less than 75 % without damage on unbearable soils (resilience very low to low);

Efficiency class III – more than 75 % of skidding roads and trails without damage on unbearable soils (resistance very low to low) or more than 75 % of skidding roads and trails with damage on bearable soils (resistance mean to extraordinary).

The state of runoff paths (RP):

Efficiency class I – natural watercourses without longitudinal and cross objects and with developed riaparian vegetation are found;

Efficiency class II – a route and stability of watercourses is particulary influenced by nature-close measures or by technical measures for water transfering under forest roads; the function of bank vegetation are limited;

Efficiency class III – hard technical measures such as longitudinal bulwarks of banks and beds, cross objects which change a waterflow direction, cross or longitudinal slope of watercourses and limit migration permeability on watercourses are located; the function of bank vegetation are partially or completely restricted.

The presence of concentrated runoff paths and gullies (code PG):

Efficiency class I – the watershed without drainage channels; existing gullies are covered by vegetation and sediment transportation does not occur;

Efficiency class II – functions of existing drainage channels are limited; there is a gradual spontaneous renaturalization; gullies are covered by vegetation without significant sediment transportation (more than 75 % of all concentrated runoff paths);

Efficiency class III – functions of existing drainage channels are preserved; gullies show a distinct dynamic of sediment transportation (more than 75 % of all concentrated runoff paths).

The height of direct runoff from the watershed (code CN):

The height of direct runoff is simply expressed using the runoff curve numbers method according to hydrologic soil groups and hydrological conditions (according Macků 2000).

Efficiency class I – hydrological soil group A and B, (C) with runoff curve numbers (CN) from 30 to 60 on more than 75 % of the watershed area;

Efficiency class II – hydrological soil group A and B, (C) with runoff curve numbers (CN) from 30 to 60 on less than 75 % of the watershed area and hydrological soil group C a D (B) with runoff curve numbers from 61 to 100 on less than 50 % of the watershed area;

Efficiency class III – hydrological soil group C and D (B) with runoff curve numbers (CN) from 61 to 100 on more than 50 % of the watershed area.

More detailed description of synthesis process is beyond the scope of this paper and is also available upon request at authors.

The final efficiency class of forest watershed is the result from a combination of criteria which take values corresponding to particular efficiency class I, II or III. The relevancy for particular criteria was said according to the fact how the criterion affects the forest watershed water regime. If the final combination of criteria is over 75 % then the watershed is classified into the efficiency class I. If the final combination is between 50 and 75 % than it is the efficiency class II and finaly if the criteria combination is below 50 % then the watershed is in the efficiency class III.

The relevancy for particular criteria, an example of their combination and the final classification of efficiency class are listed in the following tables (in Table 2, Table 3 and Table 4).

Table 2 Criteria and their relevancy for watershed evaluating and efficiency class determining (Kozumplíková 2010)

	Relevancy for criteria in efficiency class		
	I	**II**	**III**
RExA	30	20	10
CN	30	20	10
RP	15	10	5
ST	15	10	5
FR	5	3,33	1,666
PG	5	3,33	1,666

Table 3 An example of a criteria combination and the resulting percentage for classification of watershed in the efficiency class (Kozumplíková 2010)

	I	II	III	Relevancy
RExA	x			30
CN		x		20
RP			x	5
ST			x	5
FR		x		3,33
PG	x			5
			Combination	68,3

Table 4 The result of a criteria combination in relation to the forest watershed efficiency class (Kozumplíková 2010)

Results of combination	Efficiency class
> 75%	I
> 50 a < 75 %	II
< 50 %	III

The first efficiency class I is characterized by anthropogenic activities, which is zero or very limited. Forest stands are ecological stable, highly structured with natural species composition and favourable state of forest soil. Additive measures within the draft of restoration management are not necessary. Forest ecosystem fulfils a retardation of runoff and water retention completely under normal precipitation dynamics. Significant runoff of water occurs only under extreme rainfall.

The second efficiency class II is characterized by partial disturbances of the forest ecosystem by comercial activities. There is a disturbance of surface non-concentrated and hypodermic runoff and their transfer to concentrated runoff. Forest soil is disrupted by used technologies, construction of forest road network and increased production of concentrated runoff. There it occur extreme runoff at high rainfall. Additive measures within the draft of restoration management are necessary.

The third efficiency class III is characterized by intensive disturbances in forest ecosystem. There occur losses of normal water balance function, high damages of forest ecosystem, and damages of small watercourses. Forests stands are not able maintain a stable water balance due to higher rainfall. An application of long-term forest management measures and the proposal of immediate biotechnical and technical solution are necessary.

The specific proposal of forest watershed restoration management requires the proposal of individual hydric-water-management measures of preventive and compensatory character. The restoration management proposal is determined by the final watershed classification into an efficiency class. The restoration management objectives and principles for each efficiency class are shown in the following table (Table 5).

Table 5 An illustration of the principle of the draft of forest management watershed restoration (Kozumplíková 2010)

<table>
<tr><th colspan="4">The principle of the draft of forest watershed restoration management</th></tr>
<tr><th rowspan="4">Individual components</th><th>Efficiency class
I
Stable watershed</th><th>Efficiency class
II
Partially stable watershed</th><th>Efficiency class
III
Unstable watershed</th></tr>
<tr><th colspan="3">The direction of the required development of each individual component</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Balanced (low to zero) deposit of additional energy</td><td>medium (high to low) deposit additional energy</td><td>Long-term (high) deposit additional energy</td></tr>
<tr><td>1
Forest stands and forest soil</td><td>preventive and biological measures to stimulate the existing state of forest stands or without interventions</td><td>preventive, biological and biotechnical measures to support the hydric-water management function of forests and forest soil</td><td>biotechnical and reclamation measures to the overall transformation of forest ecosystems</td></tr>
<tr><td>2
Forest road network</td><td>preventive measures</td><td>preventive and biotechnical measures in case of damage</td><td>preventive, biotechnical and technical measures in case of damage</td></tr>
<tr><td>3
Water courses</td><td>without interventions, preventive measures and support of bank vegetation functions</td><td>preventive, biological and biotechnical measures and support of riaparian vegetation function</td><td>measures combination to overall restoration and renaturalization of cannels or streams incl. bank vegetation</td></tr>
<tr><td>4
Drainage of concentrated runoff</td><td>preventive measures</td><td>preventive, biological and biotechnical measuresto remediate the damage</td><td>biotechnical and reclamation measures to remediate the damage, for forests transformation can be left or implement drainage</td></tr>
</table>

4. Conclusion

The evaluating methodology of the degree of anthropogenic influence on water regime of forest watersheds is based on analyses of individual components of forest watershed.

Forests are the dominant component characterizing the forest watershed. The analyses of the current state of forest stands in based on the evaluation of species, spatial and age composition and the health status. The quantification of selected functional linkages of forest stands is differentiated on the quantification of real potentional functional abilities and quantification of real actual functional effects of forest stands and follows the basic analysis. The next evaluated component is presented by forest road network. It is proposed to separate the evaluation of forest haul roads and skidding roads and trails. The significant components are also concentrated runoff paths. Their analysis is separated on current watercourses, drainage channels and other runoff paths. The forest soil has the significant impact on forest watershed water regime. Because of this fact the evaluation of the resistance of forest soil to the logging-transport erosion is included. The analysis is finished by quantification of direct runoff from watershed.

The analytical part is complemented by synthesis part. It is defined the degree of anthropogenic influence on water regime of forest watersheds according to the determination of so-called efficiency class of forest watershed. The determination of efficiency class is based on combination of selected criteria. These criteria are as follows: the quantified real effect of hydric-water-management function in combination with the anthropic conditional functional effectiveness degree. Further criteria are the density and state of forest haul road and state of skidding road and trails in watershed; the state of watercourses; the presence and state of concentrated runoff paths and finally the height of direct runoff from the watershed.

Each criterion is characterized by relevancy according to the fact how the criterion affects the forest watershed water regime. The final efficiency class of forest watershed is classified by the combination of criteria and their relevancy. The particular restoration management and specific restoration measures are proposed depending on the efficiency class. The efficiency class I represents undamaged stable watersheds; the class II includes watesheds within partially damaged water regime (partially stable) and the class III includes heavily disturbed (unstable) watersheds.

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Flow-rate estimation of a small watercourse as a basic water balance element of a forest microwatershed

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Abstract: The hydrological balance of microwatersheds is an important factor affecting both water quality and water quantity of small water streams. The overall status of these basins, often being headwater areas, is then reflected in water bodies downstream in their ecological quality and biological diversity but also in their respective water availability, flow consistency, water storage function, flood frequency etc. The discharge from these watersheds is one of the main characteristics of the hydrological balance and thus ought to be thouroughly studied. In Czech Republic (CR) the term microwatershed was used by Máca, Nechvátal et al. (2008), who divide basins according to their sizes: micro-watersheds (elemental discharge areas), very small watersheds (10 km2), medium small watersheds (up to 80 km2) and small watersheds (over 80 km2). If the premise is accepted that small watersheds are formed by small water streams, then in case of CR these streams stand for 78% of the hydrographic network of the country but often lack continual hydrological observations (Hrádek, Sobota, 1999). The aim of this article is to present a method of flowrate estimation used on the Faculty of Forestry and Wood Technology of Mendel University in Brno on the example of a small forest watercourse flowing in the area of Training Forest Enterprise Masaryk Forest Křtiny (TFE MF). It is stated that the main reasons for the lack of knowledge of the water balance of small water streams is mainly caused by their often difficult terrain conditions, distance and inaccessability. The method used allows the elimination of these issues. It consists of a mobile Thomson spillway panel that is installed in the stream body, thus arranging a perfectly defined angular weir. Combined with an ultrasound water level sensor a rather high accuracy of flow-rate estimation is reached. This method was used to carry out two years of weekly measurements and its prime results and conclusion are presented in this paper.

Keywords: Microwatershed, water balance, forest, flow-rate estimation

1. Introduction

The hydrographic network of Czech Republic (CR) consists of totally 75,000 km of watercourses. Significant for water management are 620 of them, with approximate total length of 16,365 km (Decree No. 470/2001 Coll.) The other watercourses are referred to as small water streams (urban, forest, agriculture etc.). Even though small water streams represent most of the hydrographic network of the CR (78% of total length), they suffer from lack of continuous hydrological observations (Hrádek, Sobota, 1999). If the premise is accepted that small water streams form small corresponding watersheds, it still leaves a wide range of possible dimensions. However in recent literature a more accurate division can be found. According to Máca, Nechvátal, 2008 small watersheds are further divided into: microwatersheds (elemental discharge areas), very small watersheds (10 km^2), medium small watersheds (10 - 80 km^2) and small watersheds (above 80 km^2). Building upon this definition of watershed dimensions this paper deals with the smallest, elementary of them - microwatersheds.

These small elementary discharge areas are relatively homogenous units in the mosaic of the landscape. The fact is that all rainwater that falls onto the watershed leaves it through the pour point of the recipient, is lost during evaporation processes or increases or decreases actuall water storage. The flowrate in the recipient is one of the more easily obtained information on watersheds, yet it offers important information on the hydrological cycle of the discharge area and is one of the key parameters of its water balance.

The hydrographic network of microwatersheds is built up by small water streams, where the base flow-rate does not exceed 1 l/s during most of the year. The possible application of usuall methods of flowrate measurement (hydraulic propellers, floats) is restricted to a certain extent by several limiting attributes that most of the small water streams possess. The most common hindering factors are (from the flow-rate measurement point of view) their terrain inaccessibility and remoteness, undefined stream bed characteristics and lack of accurate climatic data.

The microwatersheds are often found in headwater areas and therefore play a significant role in both water quantity and quality of the areas downstream. The state of headwater basins contributes to the water quality, water availability, flow consistency and water storage of downstream areas and also has a direct impact on their run-off characteristics. It is these and other reasons that the water balance of the microwatersheds ought to be thoroughly studied. The aim of this paper is to present how one of the key factors of the water balance, the flow-rate, can be studied in the specific conditions of small water streams in micro watersheds.

2. Materials and methods

The experimental microwatershed is located in the Czech Republic, South Moravian district, close to Brno city and close the Moravian Karst territory. The stream where the flow-rate estimation took place is a nameless tributary of the Žilůvecký stream that is the left-side tributary of the river Svitava. The length of the mainstem is 640 m. The basin area is 65ha. The vegetation cover is mostly mixed forest by 90% (beech, oak, pine, spruce, hornbeam). Mean altitude of the basin is 332 m above sea level, mean annual precipitation is cca 620 mm and mean annual temperature is little above 7°C. The geology is mostly amphibole granodiorite.

The flow-rate in the pourpoint of the microwatershed was estimated using the method of continuous water level measurement above a mobile Thomson spillway with an ultrasound sensor. The principle goal of the method was the elimination of the most limiting attributes of small water streams. It uses a mobile Thomson spillway panel that is installed on a straight part of the stream, thus enabling the arrangement of a perfectly defined triangular weir. The fact, that the panel itself can be carried and installed by one person, thanks to its relatively small dimensions (1m) and weight makes for an ideal method for application within the field of small water streams.

As a further improvement on the method the usual registration devices (water level recorders) were replaced by an ultrasound waterlevel sensor. The sensor was connected to a data logger that was receiving data from the water-level sensor (estimating flow-rates at the same time) every 5 minutes. The data logger was calibrated before the start of the measurement using standard meter with 1 mm scale that was used to measure the height of the water level.

The ultrasound sensor – US1200 is based on the principle of measurement of a time delay between emitted and received ultrasound impulse. Its specific range is 0,15 – 1,2 m (distance between the sensor and the water level). A measurement (specific) error is not higher than 1% in the long term. The information above is taken from the manual of the producer (Fiegler-Mágr, 2010). The calibration of the control unit was performed at the beginning of every measurement via a notebook connected to the control unit in SW MOST environment. To estimate the flow-rate from the water level values, the pre-set discharge rating for Thomson spillway panel was used (1).

$$Q=1{,}3546h^{2{,}48515} \qquad (1)$$

The mobile Thompson spillway panel was made from 3 mm wide stainless metal plate and was 1 m wide and 50 cm tall.

During the years 2008-2010 (continuing in 2011) this method was applied on a small water stream in an experimental microwatershed. The mobile Thomson spillway panel was installed on the stream in two-weeks intervals (close to their points of discharge to a higher level watercourse) from May to October each year. The standard duration of the continuous measurement was 5 hours. The inter-day distribution of the measurements was from 9 am to 2 pm and from 2 pm to 7 pm. The aim was to cover the whole day time-range. Several night measurements also took place from 7 pm to 7 am the next day.

3. Results

Because of the relatively short 5 minutes writing interval a rather huge amount of number entries was provided during each of the measurements (around 60 for the 5 hour measurements). These initial data values were statistically corrected using the exploratory data analysis (EDA) approach. During this step extreme false entries caused by accidental disruptions of the flow (poorly calibrated control unit at the beginning of measurement, animals entering the stream, water flowing around the spillway etc.) were deleted. Also all values coming from the first year of measurements 2008 were erased as the methodology was not fully developed and the obtained data lacked accuracy.

The initial values were averaged for the same 5 minute intervals during a month. These were then ordered by time from 0:00 to 24:00 of a day. All values obtained in a single 5 minute interval during one month were then composed and averaged resulting in a mean flow-rate value for every single base time unit (5 minutes) of the month. Data from the two years were then averaged to create a 2-year mean value, as shown on the Fig. 1. The upper line represents data from the year 2009, the lowest 2010 and the middle line represents the two-year mean value. The main measurement times are in the darker field. During the two years a total number of 23 succesful measurements were carried out.

As shown on graph (Fig. 1) the mean two-years flowrate reaches approximately 0,75 l/s. The extreme values are: minimum 0,27 l/s and maximum 1,29 l/s. The flowrates in 2009 seem to be 0,5 l/s lower then the following year. This is mainly caused by the fact, that during the year 2010, the measurements began two months earlier thus containing may and june rainy peariod values. On the other hand, even during this year the values from august reached 0,5 l/s which corresponds to the data from the year before. It can be therefore stated that unless intense rainfall occurs, the flowrate in the stream reaches cca 0,7 l/s during most of the year.

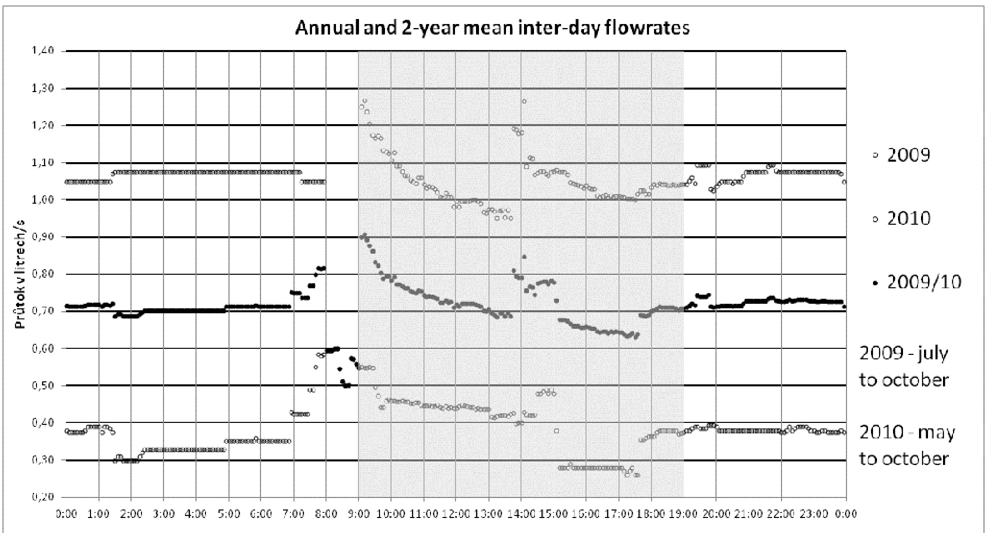

Figure 1 - The annual inter-day flowrate values during the years 2009 and 2010

Another important fact that is visible on the graph (Fig. 1) is that the flowrate seems to decrease from around 9 a.m. to cca 6 p.m. The mean total decrease reached 0,25 l/s in the year 2009 and 0,3 l/s the next year. During the two-years interval, the mean total decrease was cca 0,28 l/s. In the case of mean flow-rate (0,75 l/s) this value corresponds to 40% in relative numbers. The observed decrease is mainly caused by increased evaporation during the day (probably mostly by increased transpiration of forest ecosystems).

4. Discussion

The two years of flow-rate measurements show that the applied methodology of flow-rate estimation on a mobile Thomson spillway panel with ultrasound water level sensors is viable and allows the acquirement of data on flow-rates in the conditions of small water streams and their respective microwatersheds similar to the ones described in this paper. The main sources of inaccuracy in the measurements are of several origins: - 1; base accuracy of the Thomson weir reaches +/- 3% (www.pars-aqua.cz, 2011), 2; the accuracy of the sensor is +/- 1%, 3; the accuracy of the calibration method is +/- 0,05 cm (depending on the meter used), which according to the pre-set discharge rating for Thomson spillway used in the control unit (1) with the flow-rate 1 liter/s (example number chosen to correspond to values occurring on small water streams) and appropriate water-level 5,50 cm makes for a possible mistake of cca 0,023 liters/s, that can be looked upon as an approximately +/- 2,3% inaccuracy. With this being said the inaccuracy of this method reaches from +/- 0% to +/- 6,3%. This can be further improved by adjusting the original equation for these smaller flowrates or finding a better calibration process.

In case of strong rainfall the observed flow-rate change is very rapid. The flow-rate also alters rapidly after the rain had stopped. The most rapid change was observed on Kanice locality after a May storm event where the decrease was from 1,29 to 0,7 liters/s resulting in a decrease 0,6 liters/s during the 5 hour period which makes up for a relative decrease of 43% of the original value. This shows the effect of woody vegetation and the hydric function it provides in altering extreme flowrates.

5. Conclusion

Flowrate estimation of small water streams in forest microwatersheds using the method of water level sensors above Thomson spillways as presented in this paper brings to conclusion, methodical and factual.

The matter of fact is that from 9:00 to 18:00 a rather significant decrease in flowrate is present on the experimental basin, that was quantified to 0,28 l/s (40% in relative numbers). This decrease is in direct correlation with hydric funcions of surrounding forest vegetation.

The main methodological observation is the finding that the above described method can be succesfully used in forest microwatersheds to estimate data series of flowrates in small water streams with undefined streambed conditions. The method is environmental friendly and the installation does not damage the natural banks nor does it require water structures. These attributes predetermine this method for application in remote and less accessible areas or specially protected areas where nature protection is emphasised.

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The Romanian Forest Code (Law no. 46/2008, modified). Some opinions about it

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Abstract: In The author make a short analyze of the actual status of The Romanian forests. By this analyze he concludes that the quality and the efficiency of The Romanian Forest Code in force are not properly. This conclusion is argued in the paper by some evident examples. The paper is structured in four sections. In the 1-st section some specifications are presented. These are necessary for the best understanding of the analyze. In the second section are presented the author's findings regarding the actual status of the Romanian forests. He finds that although the activities in the forests are extremely regulated and there is a Romanian State Authority for Forest, the efficiency of this Authority is not the expected one. The author's arguments are: the aggressive attitude of the bulk of the people for the forests, the big number of the violations of the forest Law and so. In the third section are presented the causes that the author has funded for the inappropriate situation of the Romanian forests. Among these, on the one hand, some are identified in the way in which the forest regulations are. So, the author's review is that the ways in which the orders are made in the regulations make these ineffective. On the other hand, a cause of the ineffectiveness in this domain is funded in the impossibility of the State Authority for the Forests to control as the Law orders. In the fourth section the author make some proposals. By these, changes are expected in the forest regulations field. The proposed approach of this will improve the efficiency of the forest regulations. This improvement will mean both the simplification of the forest regulations and the growth of the efficiency of the State Authority for Forests.

Keywords: forest law, Romanian forest code

1. Introduction

The forests' importance it's indubitable in the present times[1]. The theme of the Conference[2], which is organized by Stefan cel Mare University of Suceava, is very generous and makes possible various onsets. In this frame, the author has made a critical and objective analysis of the manner how The Romanian Forests Authority aims its targets. The author started this analysis having regard to the perception of the majority of The Romanian People about the present status of the Romanian forests. By his analysis, the author has identified that the mainspring of this present inadequate status of the Romanian forests is the basic forest Romanian Law. For a good understanding, the author must present some references:

[1] The sentence is intended very short. The purpose is to not start an enumeration which can not be exhaustive. Every rider may inventory the aspects which sustein this affirmation.
[2] „Integrated Management of Environmental Resources"

The opinions which will be presented are determinate by the consequences of the author's personal findings and by the information receipted by the author about the ***"quality"*** and the ***"efficiency"*** of the quoted Law. The two attributes (*quality and efficiency)* are marked because it's dubitable if the Law has its![3]!

This affirmation is argued bellow:

If we adopt a "***rainbow perspective***"[4], this Law has qualities, but deficient too. By consequences, the Law is *so and so* and it has some efficiency.[5]

If we adopt a "***black and white perspective***"[6], the two attributes are missing[7].

2. Materials and methods

In the research process the author has analyzed and has used:

21 Some axiomatic truths

- It is incontestable that is necessary to have forests![8]!
- There are two kinds of forest property in Romania; private and public;
- The people are equals for the laws and for the public authorities, without privileges and differentiations[9];
- The State recognizes that every person has right to live in a health and balanced ecologically environment. The State creates the legislative framework for exercising this right[10];
- Every action (which can be an inaction, sometimes) presumes some bills;
- Every person has free access to an economic activity and free initiative. Their exercising according the legislation is guaranteed[11].
- The term 'Code" defines: *"...a legislative aggregate which regulates a justice branch… or a determinate matter..."* (1)
- The right of this Law is the Sustainable Management of The Romanian Forests.

2.2 Materials and methods

- The Law nr. 46/2008/ Forest Code and the subsequently legislation in force;
- Published works;
- Discussions in which the author was involved as participant in dialogs with private and public persons, workshops etc;
- Statistical information from The Romanian Ministry for Environment and Forests regarding

[3] It's depending about the personality (self-conscious and free individuality***!***) of the reader
[4] Indulgent (the author's opinion!)
[5] For who?
[6] A trenchant one (the author's opinion)
[7] The author's opinion
[8] First of all, ecologically

[9] The Romanian Constitution: Art.16, par.(1)
[10] The Romanian Constitution : Art.35, par.(1) and par.(2)
[11] The Romanian Constitution Art.45

the Report on the Romanian Forests Status for 2010[12];

- The author's approach in this work is "**the black and white**"[13]. It was choose for the analyses' efficiency. It is not an extremist attitude of the author.

3. Results

As result of the research some ideas (I-VIII) have appeared.

If the idea has an evident truth (self-evident), a demonstration is not made.

I. In Romania, the Forestry is very important for the State. The striking proof is the Romanian forest legislation.[14]. The basis for this "forest regulations system" is The Law nr. 46/2008, Forest Code. Subsequently is the secondary legislation.;

II. The State has institutional structures which supervise if the "forest regulations system" is respected. These structures are The County Forest Regime and Hunting Inspectorates under the authority of The Romanian Ministry for Environment and Forests.[15]

III. There are many people who violate "the forest regulation system"[16].

IV. The aggression against the forests is very strong[17].

V. The efficacy of the State forest control activity is receding. This affirmation goes having into consideration some figures. If the forest state officials observe that someone violate "the forest regulation system", they have the power to sanction the minor offences. If the law violation is a malfeasance, they have the power to complain the Prosecutor's Office.

For this research, the author has taken in consideration the statistics regarding the malfeasances.

So, he has defined the term of *"forestry control's efficiency"* as:

„The finalization's degree of the forest control officials' actions having into consideration their first actions." This definition is expressed mathematically by:

[12] Work in progress at The Romanian Ministry for Environment and Forests

[13] Presented

[14] By the author's opinion, the Romanian Forestry is excessively regulated! The argues are the number of Technical Rules and Instructions for Forestry in force!

[15] In accordance with the Governmental Decision nr. 1635/2009, Annex no.2 point 1.4 regarding the organization and the operation of the Ministry of Environment and Forests, published in Monitorul Oficial nr. 22/12.01.2010.

[16] This estimation is done, broadly speaking, by people who are not forest owners. Obviously, in a normal society, the rules are violated by a small part them.

[17] If the references is "the forest regulation system".

$$\frac{\text{The number of convictions for forest malfeasance as a result of the forest state officials' intimations addressed to the Prosecutor's Office}}{\text{The total number of the forest state officials' intimations addressed to the Prosecutor's Office}} \times 100$$

The figures which demonstrate the low level of the *forestry control's efficiency* are in the Annex nr.1[18].

So, by this definition, the *forestry control's efficiency* resulted from the cases which are finalized (97) is less than 25% (just 18.6% of cases were sanctioned certainly. For 8.2% the Court will pronounce the verdict).

This is the result of some causes that the author things have identified:

Generally speaking, the provisional part in the normative structure of the Romanian forest regulations is built in the operative-imperative manner.

So, two consequences appear at least:

a) A great number of regulations;

b) The State Forest Authority cannot control entirely how the forestry rules are respected.

The consequence from a) is demonstrated by the Annex nr.2 in which are presented a part (!!!) of the Romanian forestry regulations (The author estimates that in The Annex are presented roughly 50% of the total number of the forest regulations in force).

The consequence from b) is argued by:

b_1) the economic reality[19] in which the number of the budgetary personnel will decrease permanently. Now, the total workplaces number approved for the County Forest Regime and Hunting Inspectorates is 447[20]. But now, in Romania are functioning, according the law, 452 forestry management units (328 of them within the National Forest Administration and the other 124 are private forestry management units).

Is well known (and regulated too) how is organized a forestry management unit, respectively the existence, in every unit, of some little forestry farms.

Having into consideration these aspects, is obviously that is impossible for the State forest Authority to control if the State forestry rules (called Forest regime) are respected in the forest management units!

This impossibility is determined by the combined results of the effect of the forestry regulations conception manner and the effect of the State forestry Authority workplaces number.

$b_{2)}$ the professional and moral qualities of the forestry controllers which are, in the best case (!!!), a normal distribution[21]!

By consequence, how is respected the Forest Regime (as is imposed by the numerous forestry regulations) is and will be ***(!!!)*** not controlled***. That's why the forest regulation system is not efficient!***

VI. Another aspect, maybe less disclosed to date, is the compliance of the juridical security principle. (2).

[18] The information are from The Romanian Ministry for Environment and Forests

[19] This is not transient!

[20] By the Annex no. 2., Note 5 at the Governmental Ordinance nr. 1639/2009,

[21] The Gauss distribution

„The juridical security principle belongs to The Communitarian Legal Order and it must be respected both the Communitarian Institutions and the Union European Member States when they apply the Communitarian Directives." (2)

The aspect which is aimed is "*the accessibility of the law*". This accessibility has in association:

„..the manner how the contents of the legislation is received by the society, understanding by this how the people understand the legislation. The juridical norm must be clear, intelligible, because its receptors must be not only informed in advance about the consequences of their actions and their facts but they must understand too the legal consequences of them.

Contrariwise, the principle ***„Nemo censetur ignorare legem"*** *cannot be applied and that will have dangerous consequences for the security of the social relations, for the self-existence of the society"* (2)

The high violation's frequency of the forest regulations induces the question::

Are the forest regulations accessible?

VII. The lack of correlation of the forest regulations (special regulations) with the regulations of the juridical branches, especially with the civil juridical branch and with the criminal juridical branch (general regulations). Practical example: In the Criminal Law the lifting is a malfeasance independent of the prejudice's value. By the Forest Code, it is wood lifting if the prejudice has a certain value. If the prejudice's value is less, the Law violation is just a minor offence.[22]

VIII. The lack of equity of the Romanian Forest Regulations. The State has a strategy for Forestry. That's why it dictates rules and obligations for the forest owners. The forests are qualified by the Law as "*national level interest good*" (The Forest Code, Art. 3, par.(1)).

The most interdictions and obligations which the State dictates for the forest owners presume supplementary expenses or unrealized profit for them. The beneficiary (the society) has not pay for this.

[22] The Forest Code, Art. no. 108

4. Conclusions

1. It is necessary to review the whole concept of the Romanian Forest Regulatory System, starting with the analyze of the efficiency of the State Forestry Control activity;
2. The Forest Regulatory System must be efficient not obsolete;
3. The Forest State Authority must have a real authority, imposed by the moral and professional qualities of the employees.

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Annex no.1

The statistics of the violations of The Forest Cod (described like *crimes* by the Law) for 2010

Information from The Romanian Ministry for Environment and Forests

Nr. crt.	ITRSV	Nr. of Law violations	Rolling cases			Finalized cases				Observations
			Total (nr)	In which		Total (nr)	In which			
				Send to the Police (nr)	Send to the Prosecutor's Office (nr)		N.U.P.+S.U.P. (nr)	Penal amend (nr)	Send to the Court (nr)	
1	ITRSV Braşov									
2	ITRSV Bucureşti	**8**	8	4	4	**0**	**0**	0	0	
3	ITRSV Cluj	**164**	160	4	93	**4**	**4**	0	0	
4	ITRSV Focşani	**273**	260	62	198	**13**	**11**	1	1	
5	ITRSV Oradea	**207**	162	92	70	**45**	**25**	16	4	
6	ITRSV Ploieşti									
7	ITRSV Rm Vâlcea	**655**	627	418	209	**28**	**24**	1	3	
8	ITRSV Suceava	**261**	261	9	252	**0**	**0**	0	0	
9	ITRSV Timişoara	**360**	353	112	241	**7**	**7**	0	0	
	TOTAL	**1928**	**1831**	**701**	**1067**	**97**	**71**	**18**	**8**	
	%					**100**	**73,2**	**18,6**	**8,2**	

Annex no.2

The main forestry regulations in force

Nr.crt.	The kind of the regulation / Number/Year	Title of the regulation	The base of the regulation	Published in Monitorul Oficial-Part I number..:
0	1	2	3	4
1.	Legea nr. 46/2008	Codul silvic	Constituția României	238/27 03. 2008
2.	Ordonanța de urgență nr. 193/2008	Modificarea şi completarea art. 37 şi 39 din Legea nr. 46/2008-Codul silvic	Constituția României	825/08.12 2008
3.	Legea nr. 54/2010	Abrogarea alin. (2) şi (3) ale art. 34 din Legea nr. 46/2008-Codul silvic	Constituția României	186/24.03 2010
4.	Hotărârea Guvernului nr. 997/1999	Aprobarea Regulamentului privind constituirea, organizarea şi funcționarea structurilor silvice proprii, necesare pentru gospodărirea pădurilor proprietate publică aparținând unităților administrativ-teritoriale şi a celor proprietate privată	Legea nr.26/1996	597/08.12. 1999
5.	Ordonanța de urgență nr.59/2000	Statutul personalului silvic	Constituția României	238/30.05. 2000
6.	Legea nr. 427/2001	Aprobarea Ordonanței de urgență a Guvernului nr. 59/2000 privind Statutul personalului silvic	Constituția României	406/23.07 2001
7.	Ordinul nr. 120/ 2002 al ministrului agriculturii, pădurilor şi dezvoltării rurale	Corelarea gradelor profesionale şi a gradațiilor stabilite pentru personalul silvic cu funcțiile deținute de personalul silvic aflat în activitate la data intrării în vigoare a Ordonanței de urgență a Guvernului nr. 59/2000 privind Statutul personalului silvic, aprobată şi modificată prin Legea nr. 427/2001	Ordonanța de urgență nr.59/2000	242/10.04 2002
8.	Legea nr. 289/2002	Perdelele forestiere de protecție	Constituția României	338/21.05 2002
9.	Hotărârea Guvernului nr. 954/2002	Regulamentul pentru stabilirea modalităților concrete de gospodărire a pădurilor şi de repartizare a resurselor materiale şi a surselor financiare cuvenite persoanelor fizice şi juridice pentru pădurile pe care le au în proprietate şi pe care le administrează prin structuri silvice de stat, pe bază contractuală, precum şi a obligațiilor acestora	Legea nr.26/1996	686/17.09 2002
10.	Hotărârea Guvernului nr. 1167/2004	Modificarea art. 9 alin. (1) din Regulamentul pentru stabilirea modalităților concrete de gospodărire a pădurilor şi de repartizare a resurselor materiale şi a surselor financiare cuvenite persoanelor fizice şi juridice pentru pădurile pe care le au în proprietate şi pe care le administrează prin structuri silvice de stat, pe bază contractuală, precum şi a obligațiilor acestora, aprobat prin Hotărârea Guvernuluia Guvernului nr. 954/2002	Legea nr.26/1996	699/03.08 2004

11.	Hotărârea Guvernului nr. 548/2003	Atribuțiile Ministerului Agriculturii, Alimentației şi Pădurilor ca minister coordonator al Programului de realizare a Sistemului național al perdelelor forestiere de protecție şi componența, modul de funcționare şi atribuțiile comandamentelor județene de analiză a realizării programului anual de înființare a perdelelor forestiere de protecție	Legea nr. 289/2002	365/29.05. 2003
12.	Ordinul nr. 280/2004 al ministrului agriculturii, pădurilor şi dezvoltării rurale	Aprobarea modelului şi conținutului formularului de cazier tehnic de exploatare a masei lemnoase	Hotărârea Guvernului nr. 85/2004	416/10.05. 2004
13.	Ordinul nr. 1306/2005 al ministrului agriculturii, pădurilor şi dezvoltării rurale	Aprobarea Procedurii de aprobare, modificare, anulare şi casare a actelor de punere în valoare pentru produsele lemnoase provenite din fondul forestier, altul decât cel proprietate publică a statului, precum şi din vegetația forestieră din afara fondului forestier	Legea nr.26/1996	32/13.01. 2006
14.	Hotărârea Guvernului nr. 333/2005	Reorganizarea direcțiilor teritoriale de regim silvic şi de vânătoare în inspectorate teritoriale de regim silvic şi de vânătoare	Ordonanța de urgență nr.96/1998	354/26.04. 2005
15.	Hotărârea Guvernului nr. 1206/2007	Modificarea şi completarea Hotărârii Guvernului nr. 333/2005 pentru reorganizarea direcțiilor teritoriale de regim silvic şi de vânătoare în inspectorate teritoriale de regim silvic şi de vânătoare	Ordonanța de urgență nr.96/1998	692/11.10. 2007
16.	Ordonanță de urgență nr.139/2005	Administrarea pădurilor din România	Constituția României	243/23.03 2005
17.	Legea nr.38/2006	Aprobarea Ordonanței de urgență a Guvernului nr. 139/2005 privind administrarea pădurilor din România	Constituția României	206/06.03 2006
18.	Ordonanță de urgență nr.26/2007	Modificarea art. 7 din Ordonanța de urgență a Guvernului nr. 139/2005 privind administrarea pădurilor din România	Constituția României	282/27.04. 2007
19.	Legea nr.243/2007	Aprobarea Ordonanței de urgență a Guvernului nr. 26/2007 pentru modificarea art. 7 din Ordonanța de urgență a Guvernului nr. 139/2005 privind administrarea pădurilor din România	Constituția României	496/24.07. 2007
20.	Ordonanță de urgență nr.85/2006	Stabilirea modalităților de evaluare a pagubelor produse vegetației forestiere din păduri şi din afara acestora	Constituția României	926/15.11. 2006
21.	Legea nr.84/2007	Aprobarea Ordonanței de urgență a Guvernului nr. 85/2006 privind stabilirea modalităților de evaluare a pagubelor produse vegetației forestiere din păduri şi din afara acestora	Constituția României	240/06.04. 2007

22.	Hotărârea Guvernului nr. 483/ 2006	Aprobarea atributiilor ocoalelor silvice de stat si ale celor constituite ca structuri proprii, a obligatiilor ce revin detinatorilor de paduri, in vederea respectarii regimului silvic, precum si a Regulamentului de aplicare a Ordonantei de urgenta a Guvernului nr. 139/2005 privind administrarea padurilor din Romania	Ordonanța de urgență nr.139/2005	356/20.04. 2006
23.	Ordinul nr. 769/2006 al ministrului agriculturii, pădurilor şi dezvoltării rurale -	Aprobarea metodologiei de limitare a răspunderii patrimoniale a personalului cu atribuții de paza pădurilor	Ordonanța de urgență nr.85/12006	967/04.12.2006
24.	Hotărârea Guvernului nr. 996 / 2008	Aprobarea Normelor referitoare la provenienta, circulatia si comercializarea materialelor lemnoase, la regimul spatiilor de depozitare a materialelor lemnoase si al instalatiilor de prelucrat lemn rotund	Legea nr.46/2008	643/09.09. 2008
25.	Hotărârea Guvernului nr. 1227/2008	Completarea art. 8 din Hotarârea Guvernului nr. 996/2008 pentru aprobarea Normelor referitoare la provenienta, circulatia si comercializarea materialelor lemnoase, la regimul spatiilor de depozitare a materialelor lemnoase si al instalatiilor de prelucrat lemn rotund	Legea nr.46/2008	684/07.10.2008
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29.	Ordinul nr. 649/2008 al ministrului agriculturii şi dezvoltării rurale	Aprobarea Metodologiei de acordare a compensației pentru pierderea de venit corespunzătoare suprafețelor efectiv ocupate cu perdele forestiere de protecție înființate pe terenurile agricole	Legea nr.46/2008	761/11.11. 2008
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Use of building rubble and organic matter mixture as an innovative substrate to improve water regime in degraded soils within processes of land reclamation and reforestation

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Abstract: Success of reforestation of degraded soils is highly affected by the availability of high quality reclamation substances, which differs in its natural properties important for plants as well as in spatial accessibility for reforestation works. Because of limited natural resources in general and/or local scale, we are faced with need to find alternative resources having good quality in all parameters. In our research, we test to mix organic matter with unused building rubble - the inorganic part is not possible to recycle for building constructions and usually is stored in landfills. Reusing for rehabilitation, gives this material new "meaning of life". However before using it, numbers of tests is necessary to be passed; important are chemical and physical properties of the substance and its overall health. This paper is focused more on physical properties. There is a need of method for analyzing the necessary physical properties. For this purpose was designed equipment based on the construction of a device measuring saturated water flow in vertical column.

Keywords: degraded soils, reforestation, innovative substrate

1. Introduction

Together with the effort to rehabilitate negative impacts to the environment increases priority of preventive environmental protection. With the increasing amount of waste, we can more effectively recycle. Rear-use of waste leads to reduction of environmental burden of the landscape and saving non-renewable natural resources irrespective of the significant economic effect. If we look at the issue of reclamation and sources of materials for reclamation as well as range of recycling possibilities, such as building materials, we come to create innovative organo-mineral substrates. Substrates, which are composed of various recycled organic and inorganic origin. For this purpose we have to design cheap easy comparison method for testing new substrates. But the problem is how to test new substrate with methods for testing unimpaired samples. And this way our research set out, whose origin is briefly described in the following article.

2. Materials and methods

2.1. Basic terms

Reclamation

The term reclamation, or land reclamation, we understand as set of measures for adjustment of area damaged by natural or anthropogenic influences, focused on improvement of biological functions. Any reclamation efforts are dependent on social interest, opinion and imagination of their creators and, of course, the economic possibilities. All this parts affects the future use of the rehabilitated areas, quality of implementation and especially the consequent stability of the area.

Recycling

It is an expression for such a waste management, which leads to its further use. This is a reuse of waste and its properties as a "secondary raw material" in the production process. Recycling allows conserving renewable and nonrenewable resources and in some cases can reduce the environmental burden.

Building rubble

It is a waste from building demolitions. Recycled building materials can be used in a number of activities related to constructions. However, complete use is not yet provided. Recycled materials are from recycling of concrete, glass recycling, recycling of ceramic elements, wood, asphalt.

Machinery and equipment that are used for the recycling of building materials can modify the original rubble. Very important is the way of carrying out demolition works. In spite of efforts to use maximum in the construction industry, remains at least 20% of the material unutilized and ends at the dumps. In case of repairs and renovations of buildings is it more than 50%.

This residual material is so-called "undersize". It comes of crushing knocked down construction material, mainly brick constructions and plaster. This fine fraction, which contains a mixture of brick, lime, concrete and clay are not suitable for further use in the building. This material is badly compactable, highly absorbing and contains a heterogeneous materials. For landfilling is unpleasant side the effect of dust. Therefore, companies prefer to landfill noncrushed material.

2.2. Used Materials

Inorganic

Building rubble

This material is formed during crushing and reclassification of building bricks, lime mortar and lime plaster (internal and external). The building is from the years 1930 and therefore lime is very weathered and only slightly alkaline.

The mixture contains 52% of brick rubble fraction 0-4mm, 4% of concrete 0-4mm, 23% of sand 0-4mm and 21% of lime dust.

Silica sand

Medium grain 0,75 mm

Silica sand st 56

Medium grain 0,15 mm

Burned clay

size 1-3 mm

Organic

Peat

We used peat designed for horticultural use

Plant

Lucerne (*Medicago sativa L.)*

We have chosen this species, because of long and rich in root system. The idea of using plants is to simulate natural conditions of settle down of soils.

2.3. Used equipment

Plastic pipe: Sewer PVC pipe 200mm diameter, 450mm height, with a perforated bottom.

White non-woven fabric to protect against a fall mixture trough.

Measuring container for substrate

Measuring container for seed

The mixing blade

2.4. Methods

Preparation of pipe: First we have to put on the bottom of the pipe non-woven fabric with the same diameter as bottom. Then we placed pipes on the horizontal surface with the same properties of insolation for all samples.

Figure 1 Filter placement

Preparation of substrate: Into the mixing container we put 3 parts of peat and 1 part of sand (rubble, clay). Than mixed it and filled plastic pipe to 5cm from the top edge. After the filling, the seeds have been sown on the surface of substrate and then covered by 2cm of substrate. Than all samples was damp.

Seeds were sow in 4 samples from each kind. Fifth samples are without seeds for control comparison. Samples were on a half-shadow place and regularly controlled to prevent drying. Due to the location of samples on the open place, they were no protected from rain, but all samples were in the same weather conditions.

Figure 2 Cover of the last layer

3. Results

First plant appeared after three days. Next three days some of plants died, mostly in samples without rubble. Samples were outside during whole growing season and nowadays we make the measurement of infiltration.

For now, a clear result is that rubble due to its alkalinity reduced the pH of the mixture. This conduced to better growth. Rubble also lightens the mixture.

4. Discussion:

For the next experiment is to choose another organic part, such as horticultural substrate, or topsoil, or subsoil. The question is, whether choose only one type of horticultural substrate for next experiments. Then we can provide same properties and comparable results for all measurements. Another change could be replacing fabric layer with drainage layer, or other material from natural sources (jute, sisal.). Essential is, to know origin of the rubble for next experiments.

Figure 3 Steps to filling of the cilinders

5. Conclusion

We are at the beginning of the experiment, but now we can say, that the device should work as we expected. The first measurement is currently underway and we will have to fine-tune procedures. Then the results will be comparable. For the next experiment we plan to replace a non-woven fabric with other material or drainage layer. It is also planned to apply the method in a pilot plant condition in cooperation with the company from the private sector.

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