HIGHLIGHTING THE ECONOMIC AND FINANCIAL LOSSES IN ECOSYSTEMS, WITH SPECIAL REFERENCE TO THE FOREST ECOSYSTEMS OF THE BARGAU MOUNTAINS

Valentin LUPSAN, PhD Student
"Marin Dracea" National Institute for Forestry Research & Development, Bucharest
E-mail: lupascuv@yahoo.com

Abstract:

At the moment, the disruptions (mainly negative ones) in the social &economic systems have fewer short-term solutions, and the medium and long-term ones disregard the greater sustainable development at micro, meso and macrolevels.

The economic and financial losses registered in such eco-systems, affected by disruptions of their stability and integrity, lead, in most cases, to major climate changes, especially at regional level and in the local zones, with unexpected, diverse and sometimes irreversible implications for the ecological environment. A quantifiable value for such losses, which are both quantitative and qualitative, in a specific case (the losses in terms of Norway spruce, Picea abies, forests affected by biotic and abiotic factors in the Bargau Mountains) may provide new approach methods.

This is the view which interests us: the economic and financial losses may be quantifiable in terms of effects of the disruptions caused, a 'snowball' effect, with larger damages (losses) in the adjacent zones or downstream of the Bargau Mountains (a situation that can be generalised).

Forest ecosystems are affected quantitatively by several destabilizing factors, in particular due to the action of wind and snow and the quality of the wounds caused by the large game, by way of a decrease in the wood (bears, deer). Three of the four ecosystems are located in the Management Units (working circle)II Iliuta from the Tihuta-Colibita RA Forest District, in the sub-divisions: 75 C and 662 B, for which research has been conducted on the 60 year-old-ecosystem, and 363 D, where the ecosystem is 120 years old.

Keywords: *economic losses, eco-systems, disturbance, climate changes, 'snowball', cause, effects.*

JEL Classification*: Q01, P51, Q15*

1. Introduction

At the moment, the problems of the disruptions (especially negative ones) in the economic and social systems have fewer and fewer short-term solutions, and the medium and long-term ones disregard, to a greater extent, sustainable development at macro, meso and microeconomic level.

For a sensible management of forest ecosystems of conifers, particularly spruce, affected by abiotic and biotic disruptive factors, over time, research has been conducted, both worldwide and nationally, resulting in outcome presenting the quantitative and qualitative quantification of economic and financial losses, in the natural stands from the natural conifer range, published in the relevant journals. There have been fewer attempts to quantify these disruptions based on value because they are rather hard to quantify in terms of value, especially as regards the side effects occurring in such ecosystems in their production area and the areas adjacent to such phenomena. Forest ecosystems must be viewed, in economic and financial terms, as dissipative systems, where entropy plays a fundamental role in the organisation of the systems, sometimes irreversibly changing them. We have the following paradox: the better we organise the economic and social system, the more disorganised the biological systems (ecosystems) become.

Although "coniferous species are in better and more stable health condition than deciduous species, as the climate conditions have significant influence, and the water deficit and thermal excess are far more common in regions where the deciduous species are clustered" (Badea Ov., Neagu St., 2007), they are more vulnerable to destabilising factors (particularly felling caused by wind and snow) due to the more austere climate conditions and the more unstable rooting system. This imbalance occurs especially in forest ecosystems with conifers, mostly spruce, around the age of 60, as a result of not performing maintenance works (cleaning and thinning) in a timely manner, leading to the creation of stands with a slenderness ratio greater than 1, with full consistency. The wounds caused to the tree trunks by the large game: the Carpathian deer (*Cervus elaphus*) and the bear (*Ursus arctos*), are entry routes for the spores of various fungi that cause red rot in conifers. The attacks of *Ipidae* also cause major disruptions in the forest ecosystems and soil erosion by reducing the anti-erosion and hydrological role causes long-term disruptions. L. von Bertalanffy (1956) defines the system "as a complex of elements that are in constant interaction with one another" (Milescu, I., 1994, page 13). The systems consist of a set of elements that are in constant interaction, forming a whole, the properties of which are superior to or other, in terms of quality, than the sum of the components, which are defined as subsystems.

An ecosystem is, by definition, "the unity between the living community (biota) inhabiting a given territory and that territory, defined based on topographic and climatic homogeneity and administrative criteria, the biotope" (Ionescu Al, Sahleanu V. and Bindiu C., 1989, page 73).

As the human society has evolved, social and economic systems have also developed, culminating in massive technological development, recording countless errors, sometime seven genuine environmental disasters for mankind. It is worth mentioning, in the economic systems theory, that "maintaining the steady state of economic systems (more generally social ones) accelerates the increase of environmental entropy" (Dinga, E., page 62).

Thus, if "the wood offered for sale comes from accidental products, then the slope of demand increases because the residual value of each meter bought decreases more than in the case of a normal supply since the operating expenses per unit of product are higher" (Dragoi M., 2000, page 39).

When quantified in terms of value, such losses, both the quantitative and the qualitative ones, in a specific case (the losses in the spruce stands affected by biotic and abiotic factors in the Bargau Mountains) may provide new approaches to the problem. The resulting wood is poor quality and low in quantity since tree harvesting is done before the usability age, as established by forestry work plans. The resulting disruptions cause a 'snowball' effect, with greater damage (losses) in the areas adjacent to or downstream of the Bargau Mountains and are a direct consequence of the "artificialization of forests" (Giurgiu V. 1978, page 265) and the situation can be generalised.

2. The site of the research and the research methods

The research has been conducted in four ecosystems (stands) under the same steady conditions (biotope) and with the same vegetation (biota), deconstructed, and selected as representative samples, in which the spruce is prevalent, within the Tihuta-Colibita R.A. Forest District managing a large part of the private forests in the Bargau Mountains.

Photo1. Forest system affected by destabilising factors (forest management unit 75C)
Photo2. Degraded ecosystem (forest management unit 662B)
Photo: Eng. Valentin Lupsan

Of these, two are 60 years old (young stands), and one of them, for comparison purposes, is 120 years old (mature and usable) and they are affected, both quantitatively and qualitatively, by biotic and abiotic factors, especially felling caused by wind and snow and wounds caused by the large game by way of the wood quality decline (bears, deer). In preparing this study, in order to meet the targets set by the theme, the following research methods have been employed: observation, experiment and synthesis.

The following table presents the forest management units (sub-plots) in which the research took place, with their main biometric and steady characteristics, according to the plan of the production unit **II Iliuta**, with in the Tihuta-Colibita Forest District.

Table 1

Experimental area in the representative stands of the Bargau Mountains

No.	Forest District	Production Unit (P.U.)	Forest manag. unit (f.u.)	Area off.u. (ha)	Inventoried area (ha)	Current age (years)	Production class	Type of post	Type of forest	Proposed treatment
1	Tihuta-Colibit a R.A Forest District	II Iliuta	75 C	3.00	3.00	60	2	3333*	1311**	Progressi ve cutting (alignme nt)
2		II Iliuta	363 D	2.09	1.00	120	1	3333	1311	Progressi ve cutting (alignme nt)
3		II Iliuta	662 B	13.59	1.40	60	1	3333	1311	Progressi ve cutting (alignme nt)

* *Mountainous; mixture P_h (high productivity), large brown soil, with Asperula-Dentaria;*
*** Normal mixture of conifers with beech and Mull(s) flora*

In these stands, full inventory has been taken, as they are stands which fall within the category of first regeneration emergency, in terms of the forestry regulations in force. The result of the full inventory of the stands to be exploited has materialised in the distribution, by diameter categories and quality classes and representative heights, for trees with a diameter close to dgM (average central diameter of the base area) for each species making up the stand in the calculation of the APV (the technical and economic document calculating the volume by species and assortments of the wood material resulting from the inventory), the prices are set for each species and assortment separately and are the basic element in the organisation of timber auctions for the economic agents exploiting the timber.

3. Intermediate results

The proper management and accurate assessment of the forest resources despite the on going and alarming decrease of forest-covered areas involves a harmonisation of the exploitation and use of the wood obtained with the environmental requirements of forest ecosystems, without disturbing their biological activity too much, as they work based on the principle of self-preservation of the dynamic balance, by ensuring their integrity and continuity for future generations, in accordance with the principle of sustainable forest management. The first two stands from the forest management units: 662B, 75C fall within the category of regeneration emergency 11.The stand in the forest management unit 363D is past its technical usability age, and has been included in the category of regeneration emergency 21.

Table 2
Base data for calculating the timber volume of the experimental areas

No.	No. of f.u. (forest manag. unit)	Species	Diameters (cm)		Heights (m)		Age (years)	Average tree volume (m^3)	No. of trees	Increase	APV no.
			dt	dcg	ht	hc					
1	662B	MO (spruce)	30.3	30.2	28.5	28.5	60	0.800	225	0	4161
2	75C	MO	34.8	31.2	26.3	25.4	60	0.590	656	0	3765
		BR (fir)	40.8	38.9	24.8	24.4	65	0.860	102	0	

		FA (beech)	40.0	41.8	23.0	23.4	65	0.450	138	0	
		PAM	20.0	19.3	15.6	15.4	60	0.120	43	0	
		ULM (elm)	19.0	17.7	16.3	15.9	60	0.170	6	0	
3	363D	MO	43.5	43.3	30.6	30.5	120	1.370	57	0	4177
		BR	48.3	48.2	30.7	30.6	120	2.000	31	0	
		FA	50.8	50.4	29.8	29.7	120	2.290	34	0	

The decrease in the consistency (density) of the stand is mainly due to the felling caused by wind and snow in 2011 (evenly spread across the entire area), in the stands from the forest management units: 662B and 75C, where restoration environmental reconstruction works have been proposed, by way of the progressive alignment cutting, followed by a forestation and caring for the area of seed spruce installed.

The forest ecosystem at the forest management unit :363D is a stand past its technical usability age, where mass felling has been reported, due to wind and snow, grouped across a 1.4 ha portion of the 13.59 ha of the entire subplot (forest management unit). The tendency of succession of the spruce species to the detriment of the beech may be noticed.

Having processed the data using the APV calculation software, the volume of timber per experimental area (portion) has been obtained, and the results are quantified in the following table.

The economic losses are assessed in relation to the reference state, i.e. the reference age, which, for the prevalent species, the spruce, in the natural range, is the technical usability and, for the one outside the natural range, is the absolute usability. Neither one is justified economically.

Table 3

Wood volume in the experimental areas (portions) by dimensional and primary assortments

No.	No. of f. u. (forest unit)	Species	Volume of dimensional sorting (m^3)						Volume of primary sorting (m^3)						Value (RON)
			G1	G2	G3	M1	M2	M3	Thin wood	Work wood	Bark	Fire wood Total	Fire wood From branches	Gross	
1	662 B	MO	5	74	33	29	8	0	3	152	17	10	7	179	28489.00
Total			**5**	**74**	**33**	**29**	**8**	**0**	**3**	**152**	**17**	**10**	**7**	**179**	**28489.0**

															0
2	75C	MO	29	147	61	59	21	0	10	327	36	26	16	389	66740.00
		BR	29	26	8	7	3	0	1	74	8	6	5	88	18274.00
		FA	5	5	0	2	2	2	1	17	1	44	4	62	4193.00
		PAM	0	0	0	0	1	1	1	3	0	2	1	5	315.00
		ULM	0		0	0	0	0	1	0	0	0	0	1	33.00
Total			**63**	**178**	**69**	**68**	**27**	**3**	**14**	**422**	**45**	**78**	**26**	**545**	**89555.00**
3	363D	MO	29	22	6	5	2	0	0	64	6	8	3	78	13635.00
		BR	35	12	3	2	0	0	0	52	5	5	4	62	12327.00
		FA	9	7	0	1	0	0	0	17	1	60	4	78	4968.00
Total			**73**	**41**	**9**	**8**	**2**	**0**	**0**	**133**	**12**	**73**	**11**	**218**	**30930.00**

In the economic and financial logic, any income which arises faster than originally planned is welcome, because the present value is greater. If one does not take into account the discount rate, one only uses the increase losses and an average price of wood is applied to these.

In order to stress the economic and financial losses over a period of planning (10 years), one has taken into account the volume of the stands by species, production classes, consistency, at the age of 50, for the stand in the forest management unit: 662B, 75C, for the forest management unit 363D,the reference age being 110 years, by using the calculation methodology below.

The calculation of the "central diameter of the base area (dgM) is a median calculated in relation to the base area" (Giurgiu V., 1979, page 174):

$$dgM = dM + C\frac{\left(\frac{G}{2} - SM\right)}{gn} ,$$

(1)

where:

dgM–the central diameter of the base area;
dM–the lower limit of therange for the diameter category including G/2;
C–the size of the diameter category (2cm);
G–the total base area;
SM–the accumulated base area up to the range of the diameter category including G/2;
gn –the base area of the diameter category including G/2.

The *corrected average height (hgMc)* is calculated using the following formula (Giurgiu V., 1979, page 195):

$$hgMc = \left(1.36 - 0.36\frac{d}{dgM}\right)h \quad (2),$$

where*: d – the average arithmetic diameter of the trees inventoried by species;*
h – the average height of the trees inventoried by species.

After calculating dgM for the trees with diameters close to it, 10 to 15 heights are measured for each tree species inventoried. For the spruce species, 15 heights were measured for each experimental area separately, and, for the other species, 10 heights were measured for each species.

The base area of the stand is obtained by adding up the multiple base areas by categories of diameters (ni, gi):

$$G = n1\frac{\pi}{4}di^2 + n2\frac{\pi}{4} + \cdots +, nk\frac{\pi}{4}dk^2 = \Sigma di^2 ni = \Sigma nigi$$
(3)

The calculation of the average tree volume is obtained using the equation proposed by Giurgiu and implemented in the APV calculation software, based on the relation below:

$$\log v = bo + b1logd + b2log^2\ d + b3logh + b4log^2\ h4$$
(4)

And the equation coefficients were determined using the method of the smallest squares for each individual species.

In order to determine the working wood volume and break it down by primary and dimensional assortments, the sorting tables are applied to the stands on the main forest species inventoried. The application of these tables requires knowing the following data: the total volume of the stand, the average diameter of the base area (dg) and the proportion of the work trees (first quality class).

The establishment of the number of work trees by equalling the trees in classes II, III and IV is performed by multiplying the number of trees in the corresponding quality classes by the related equivalence ratios for such classes for:

- Conifers:

$N = NI + 0.94NII + 0.81NII + 0.17\ NIV$

(5)

- Deciduous trees:

$N = NI + 0.81NII + 0.57\ NII + 0.17NIV$ *, where:*

(6)

NI…NIV is the number of trees in classes I to IV after the inventory

The tree quality is estimated "through a careful visual analysis, by monitoring the shape of the trunk and any potential defects that may result in the downgrading of the working wood or of the trees from a quality class to another one, due to the size and position on the trunk of the defective portion" (Decei, 1986 quoted by Iosif Leahu 1994, page 269).

Next, the sorting tables are applied for the stands based on the average diameter, by applying the following formula:

$$Vs = Vpi\ P$$

(7)

where:
Vs – the volume of the assortment;
V – the total volume;
Pi–the sorting index expressed as percentages, for assortment i;
P – the percentage of work trees.

For the volume of the branches, the formula is simplified, i.e.:

$$Vc = VpPcr$$

(8)

The volume of the fuel wood (Vf) shall result by deducting, from the total volume (V), the volume of the working wood (V1), plus the volume of the bark (Vco) and the branches (Vcr), hence:

$$Vf = V-(V1+Vco+Vcr) \quad (9)$$

Moreover, before sorting, for trees fallen due to wind and snow, one should consider the application of the downgrading and loss indices (technical regulations for assessing the timber intended for use, 1986, p. 53, 80, 82) accounting for 2% and 1%, respectively, out of the total volume. For a correct application of these indices, along with the inventory of the trees, one shall record data on the height where the break has occurred. To that effect, an average height of the break has been calculated as an average of the heights by diameter categories. The following stages of work are required: an inventory of the trees and a quality classification. For broken trees, one shall put down the indicator 'broken', as well as the height of the break; the measurement of the heights (2-3) of the trees in each diameter category for both whole trees, and broken trees and the calculation of the total volume and the volume by assortments.

In these stands, from the production tables, one has taken the volume by species and production classes, at the current age (60 years for the three aforementioned experimental areas and 120 years for the experimental area at the forest management unit 363D) from the paper *Biometria arborilor si arboretelor din Romania, 1972* (Biometrics of Trees and Stands in Romania, 1972) and, considering that the consistency of the stands has remained the same as the original one, disregarding the accidental product cutting executed over the 10 years (which has significantly reduced the consistency to 0.2, 0.3, causing the studied stands to fall within the category of regeneration emergency 1). Based on the difference between the volume that should have existed at the present time (the time of the latest cutting) estimated in theory and the original volume of 10 years ago, the periodic current increase in volume has been determined. By dividing the regular current increase by the number of years in the period (10 years), one obtains the periodic average increase in volume per year. By dividing the periodic average increase in volume by the area of the stand, one obtains the annual average increase in volume.

The calculations for determining the losses of value due to the increase losses have been performed for each individual experimental area.

For the portion from the forest management unit 662B, the calculations have been performed as follows:

- From the production tables, for the 60-year-old1st production class spruce stand with full consistency (1.0), per hectare, the main production volume is 772 m^3 and, at 50 years of age, the main production volume under the same conditions should have been 671 m^3;

- The current composition of the stand is 10MO; the current consistency of the stand is 0.2 and the consistency 10 years ago was 0.8, according to the description by plots in the previous plan;
- The injuries are concentrated across an area of 1.4haout of the 13.59ha of the forest management unit. The volume of timber at the age of 50 shall be calculated using the following formula:

$$Vsp = Vt x P x k x Spr \quad (10)$$

where:

Vsp–the volume for each species, at that age, participating in the make-up of the stand;

P – the share of participation of the species in the make-up of the stand;

k – the consistency (density of the stand);

Spr – the area of the stand.

By applying the formula in this case: $V_{initialMO.50}$ =6710x1.0x 0.8x1.4=751.52m^3 (for facilitating the calculations for the volumes, rounded values shall be used).

Thus, V_{MO50} =752m^3 and it represents the total (initial) spruce stand volume at the age of 50.

$$V_{estimated\ MO60}=772x1.0x\ 0.8x1.4m^3,\ V_{MO.60}=865\ m^3$$

The hypothetical estimated volume, when keeping the 0.8 consistency and adding periodic increases, at the age of 60,for the studied spruce stand ($V_{estimated\ MO60}$),is the volume that would have been obtained without the disruptive factors (felling due to wind and snow and injuries caused by the large game, insect attacks etc.).

The periodic current increase in volume (Ccp) is obtained as the balance between the volume of the spruce stand at the age of 60 and the volume of the spruce stand at the age of 50, as follows:

$$C_{CP}=V_{MO60}-V_{MO50}, \quad (11)$$

$$C_{CPMO} = 865-752 =113\ m^3$$

By dividing the periodic current increase in volume by the number of years in the period (10 years), one obtains the periodic average increase (Cmp) in a year, according to this formula:

$$Cmp = \frac{CCP}{N},$$

(12)

where: *N – the number of years in the period.*

For this case, C_{mpMO}=113/10=11.3m^3/year. Based on the difference between the estimated spruce stand volume $V_{estimated\ MO60}$ (865 m^3) and the existing volume at the time of the exploitation $V_{existing\ MO60}$ in the stand (179 m^3 according to the APV) after extracting the volume from the accidental cutting (cuts not planned in the plan, which occur due to the interaction between the stand and the destabilizing factors), an extracted theoretical volume ($V_{extracted}$) results, over the course of the 10 years, of 686 m^3. Due to the fact that the accidental product cutting occurred in 2010, four years after the development of this APV (project evaluation report – in Romanian 'Act de Punere in Valoare'), the stand only loses the periodic average increase over those four years (11.3m^3/year x 4 years= 45 m^3). In relation to the area of the portion, the losses in volume per hectare are: 45 m^3/1.4ha = 32.14 m^3/ha^{-1} (m^3/year/ha). The difference between the theoretical extracted volume ($V_{extracted}$) in the stand by accidental cuts and C_{mp}in four years is the actual volume used from the accidental cutting in 2010.

Knowing the total amount, in RON, of the gross volume of wood from the forest management unit 662B and the volume to be harvested according to APV, the following values result:

28489 RON/179 m^3=159.156 lei/m^{3}of wood.

By multiplying the average price of a cubic meter of spruce wood by the increase losses in the spruce stand during the extraction of the accidental products up to the stand inventory and preparation of the APV, the following loss in value results:

45 m^{3}x 159.156 RON/m^{3}of wood = 7162.02 RON.

By relating the loss in value to the area in hectares of the experimental area, the following results:

7162.02 RON/1.4ha, with a loss in value of 5115.73 RON/ha.

Figure 1 shows the values of the economic and financial losses due to the disruptive factors at the forest management unit 662B.

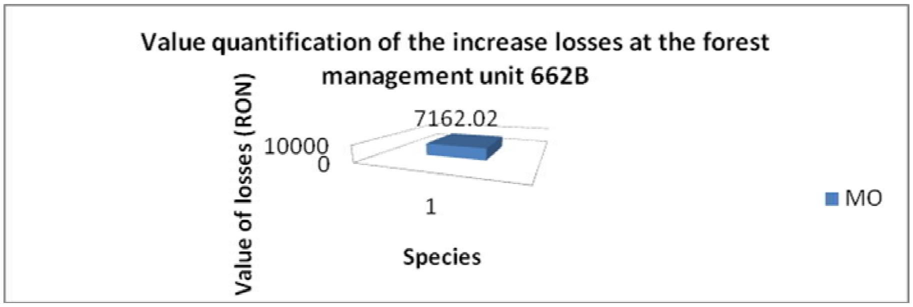

Fig.1. Value quantification of the increase losses for the spruce species at the forest management unit662B

At the experimental area of the forest management unit 75C, the stand has the following characteristics:

- The current composition of the stand is 8MO 1BR 1FA;
- The current consistency is 0.3 and, 10 years ago, it was 0.8;
- The injuries from the biotic and abiotic factors are scattered across the entire area of the forest management unit.

Using the same economic calculation algorithm, for the experimental area (portion) of the forest management unit 75C, we obtain as follows:

- By using the formula (10) for the spruce species, the following values result:

$V_{initialMO.50}$ =536x 0.8x0.8x3.0=1029 m^3

$V_{estimated\ MO60}$=627x 0.8x0.8x3.0 =1204m^3, $V_{estimated\ MO60}$ = 1204 m^3

- For thefir species, we have the following values:

$V_{initial\ BR.50}$ =430x 0.1x0.8x3.0=103 m^3

$V_{estimated\ BR\ 60}$ =532x 0.1x0.8 x3.0 m=128 m^3, $V_{estimated\ BR60}$ = 128 m^3

- For the beech species, we have the following values:

$V_{initial\ FA.50}$ = 335x 0.1x0.8x3.0=80 m^3

$V_{estimated\ FA\ 60}$ = 401x 0.1x0.8 x3.0 m=96 m^3, $V_{estimated\ FA60}$ = 96 m^3

- By applying the formula (11), one obtains:

C_{CPMO} =1204-1029 =175m^3

C_{CPBR} =128-103=25m^3

C_{CPFA} =96-80=16m^3

- By applying the formula (12) for each component species of the forest management unit 75C, one obtains:

$C_{mp\ MO}$ =175/10 =17.5m^3/year

$C_{mp\ BR}$ =25/10 =2.5m^3/year

$C_{mp\ FA}$ =16/10 =1.6m^3/year.

Based on the difference between the estimated volume of spruce species $V_{estimated\ MO60}$ (1204 m^3)and the existing volume at the time of the exploitation $V_{existing\ MO60}$ in the stand (389 m^3 according to the APV), after extracting the volume from the accidental cutting, a theoretical extracted volume ($V_{extracted}$) results, over the course of 10 years, of 815 m^3.

For the fir species $V_{estimated\ BR60}$ (128 m^3) and the existing volume at the time of the exploitation $V_{BR\ existing\ BR60}$ in the stand (88 m^3 according to the APV) after extracting the volume from the accidental cutting, a theoretical extracted volume ($V_{extracted}$) results, over the course of 10 years, of 40 m^3.

For the beech species, based on the $V_{estimated\ BR60}$(96 m^3) and the existing volume at the time of the exploitation $V_{FA\ ULM\ PAM\ existing\ BR60}$ in the stand (68 m^3 according to the APV) after extracting the volume from the accidental cutting, a theoretical extracted volume ($V_{extracted}$) results, over the course of 10 years, of 28 m^3.

The difference between the theoretical extracted volume ($V_{extracted}$) in the stand by accidental cutting and C_{mp} for three years, for all three species represented in the stand, especially spruce as the main species, represents the actual volume used from the accidental product cutting in 2011:

- For the spruce species: 815-(17.5m^3/year x3 years)=815-53=762m^3;
- For the fir species: 128-(2.5m^3/year x 3 years)=128-8=120m^3;
- For the beech species: 96-(1.6m^3/year x 3 years)=96-5=91m^3.

The following table presents the increase losses for all the species making up the stand (where the majority species is the spruce) and their value quantification.

Table 4
Value quantification of the increase losses for the forest management unit 75C

No.	**Species**	**Average periodic increase**	**Average annual increase**	**Unit price per**	**Value of losses (RON)**	
					Per	Total

		losses (m^3/year) Rounded values	losses (m^3/year ha^{-1})	species (RON)	hectare	
1	MO – spruce	53	17.5	171.568	3002.440	9093.104
2	BR – fir	8	2.5	207.659	519.147	1661.272
3	FA – beech	5	1.6	66.779	106.846	333.895
Total stand		66	-	-	3628.433	11088.271

Figure 2 presents the values of the economic and financial losses due to the disruptive factors at the forest management unit 75C.

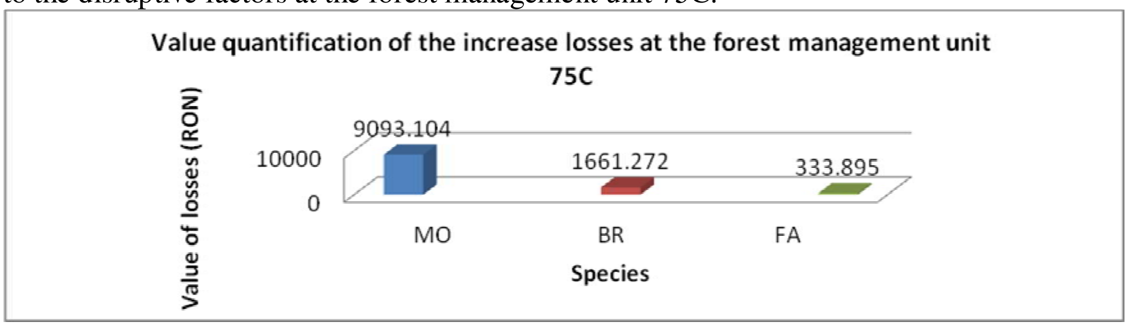

Fig.2. Value quantification of the increase losses per species at the forest management unit 75C

The volume of $973m^3$ from accidental product cutting was used in 2011.

In terms of value, the increase losses for the entire stand at the forest management unit 75C,for a period of three years, is 12.38% of the amount of the wood exploited via the latest cutting according to the APV.

By using the same economic calculation algorithm for the experimental area (portion) at the forest management unit 363D, we obtain:

- By using the formula (10) for:
  - The spruce species, the following values result:
    $V_{initialMO.50}$ =859x 0.5x0.7x1.0=301m^3
    $V_{estimated\ MO60}$ = 877x 0.5x0.7x1.0 =307m^3, $V_{estimated\ MO60}$ = 307m^3
  - The fir species,the following values result:
    $V_{initial\ BR.50}$ = 810x 0.3x0.7x1.0=170 m^3

$V_{estimated\ BR\ 60}$ = 833x 0.3x0.7 x1.0 m = 175m^3, $V_{estimated\ BR60}$ = 175m^3

- The beech species, the following values result:

$V_{initial\ FA.50}$ = 625x 0.2x0.7x1.0=87 m^3

$V_{estimated\ FA\ 60}$ = 652x 0.2x0.7 x1.0 m=91 m^3, $V_{estimated\ FA60}$ = 91m^3.

- By using the formula (11), one obtains:

  C_{CPMO} = 307-301 = 6m^3

  C_{CPBR} = 175-170 = 5m^3

  C_{CPFA} = 91-87 = 4m^3.

- By using the formula (12) for each component species at the forest management unit 75C, one obtains:

  $C_{mp\ MO}$ = 6/10 = 0.6m^3/year

  $C_{mp\ BR}$ = 5/10 = 0.5m^3/year

  $C_{mp\ FA}$ = 4/10 = 0.4m^3/year.

Based on the difference between the estimated volume of spruce species $V_{estimated\ MO60}$ (307m^3)and the existing volume at the time of the exploitation $V_{existing\ MO60}$ in the stand (78m^3 according to the APV) after extracting the volume from the accidental cutting, a theoretical extracted volume ($V_{extracted}$) results, over the course of 10 years, of 229m^3.

For the fir species $V_{estimated\ BR60}$ (175 m^3) and the existing volume at the time of the exploitation $V_{BR\ existing\ BR60}$ in the stand (62 m^3 according to the APV) after extracting the volume from the accidental cutting, a theoretical extracted volume ($V_{extracted}$) results, over the course of 10 years, of 113 m^3.

For the beech species $V_{estimated\ BR60}$ (91 m^3) and the existing volume at the time of the exploitation $V_{FA\ existing\ BR60}$ in the stand (78m^3 according to the APV) after extracting the volume from the accidental cutting, a theoretical extracted volume ($V_{extracted}$) results, over the course of 10 years, of 13 m^3.

The difference between the theoretical extracted volume ($V_{extracted}$) in the stand by accidental cutting and C_{mp} for three years for all three species represented in the stand, especially spruce as the main species, represents the actual volume used from the accidental product cutting in 2011:

- For the spruce species: 307-(0.6m^3/year x3 years)=307-2=762 m^3;
- For the fir species: 175-(0.5m^3/year x 3 years)=175-2=173 m^3;

- For the beech species: 91-(0.4m^3/year x 3 years)=91-1=90m^3.

The following table presents the increase losses for all the species making up the stand (where the majority species is the spruce) and their value quantification.

Table 5

Value quantification of the increase losses for the forest management unit 363D

No.	Species	Average periodic increase losses (m^3/year) Rounded values	Average annual increase losses (m^3/year ha^{-1})	Unit price per species (RON)	Value of losses (RON)	
					Per hectare	Total
1	MO – spruce	2	0.6	174.808	104.885	349.616
2	BR – fir	2	0.5	198.822	99.411	397.644
3	FA – beech	1	0.4	63.692	25.477	63.692
Total stand		4	-	-	229.773	810.952

In terms of value, the increase losses for the entire stand at the forest management unit 363D, for a period of three years, is 2.62% of the amount of the wood exploited via the latest cutting, according to the APV. This shows that, with the aging of the stands, the increases are lower and, therefore, the losses due to the increases are lower, becoming almost non-existent for a stand past its technical usability age. Figure 4 shows the economic and financial losses due to the disruptive factors at the forest management unit 363D.

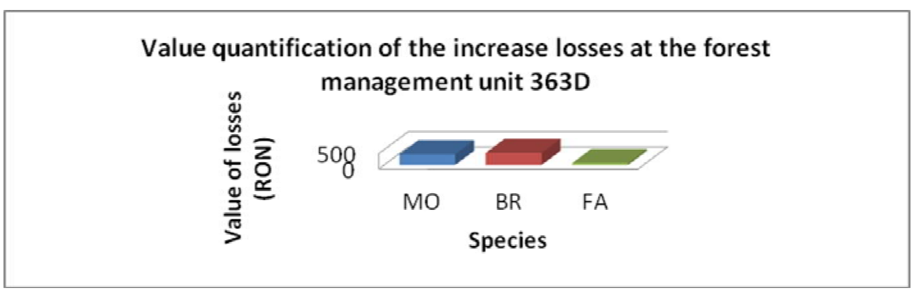

Fig.4. Value quantification of the increase losses per species at the forest management unit 363D

4. Interpretation of the results and final conclusions

The interference between the economic & financial, the economic& social and the biological systems has, in most cases, led to major changes within the biological systems (ecosystems), economically quantifiable in terms of value as losses, i.e. as deviations from a normal structure.

Economically speaking, everything that does not correspond to a normal state of dynamic balance between these triggering factors shall be recorded as losses.

When transposing the situation in the case of forest systems, the increase losses due to the action of negative disruptive factors, such as high-intensity wind, snow, leads to disturbances in the chain, in the specific environment of forest systems. Thus, the quantitative and qualitative wood depreciation has a negative local impact on the economic-financial and social systems in the area. Since wood is a commodity, when it depreciates, under the influence of disruptive abiotic and biotic factors, it can no longer be stored, the same as for any unaffected systems. It must be used as soon as possible since a greater depreciation of its quality over time leads to growing economic and environmental losses.

The impact on the forest environment has direct local implications, as well as indirect implications that are difficult or sometimes impossible to quantify in terms of money. The degradation of the forest systems has major effects on the anti-erosion and hydrological system, leading to floods in the surrounding areas, as well as climate changes because there is no longer the balance created in the natural biological systems where there are no disruptive factors. Once the forest systems are affected, their recovery sometimes involves very high costs, and a long recovery.

The analysis of the three stands considered in the study shows that the increase losses are higher in the young stands (they are frequent around the age of 60 since the increases are also more active in this period) and are lower in the stands past their usability age (the forest management unit 363D).

The forest systems influence evapotranspiration, reduce leaks and a forest ecosystem affected by disruptive factors can no longer optimally fulfil its hydrological role because some of the rainfall is no longer retained, the snow no longer melts slowly and the litter is carried away by the rainfall water, especially for the high water on the slopes and, hence, local erosion appears and, in the downstream surrounding areas, floods occur and cover the culture land with mud and clog the reservoirs (in this case, the Colibita reservoir). The affected stands can no longer counteract the action of the strong winds as they are exposed to degradation at all times, up to the occurrence of the mass windfalls.

The economic and financial losses that are hard to quantify in terms of value are those that influence the climate of the zone: the forest ability to store carbon and produce oxygen, to neutralize pollutants, to enrich the air with negative ions, anti-microbial substances (phytoncides).

The treatments applied to the studied stands (the forest management units 662B, 75C and 363D) are progressive ones, for alignment, since there are natural seed tree areas already installed, as reforestation for a percentage of the area of the unit and the caring for the new cultures are required.

Furthermore, the losses recorded in such stands are not only the quantifiable ones that can be assessed in economic and financial terms; but also the environmental ones, which are much harder, and sometimes impossible to quantify in economic and financial terms, which lead to major climate changes, the so-called 'snowball' effect, in the areas affected by the disruptive factors and, implicitly, in the adjacent areas located downstream. Besides the loss of timber, there is a series of extra costs for forest regeneration in these stands, where the ecological environment of the forest is affected. A deconstructed forest can no longer optimally fulfil its hydrological and anti-erosion role.

The biodiversity and ecosystems are also under pressure. The solution is to invest in innovation right now, to support a green economy – an economy in harmony with the natural environment, in order to minimise the effect of the climate changes as much as possible.

As one can see, the greater frequency of the disruptions due to the negative action of the biotic and abiotic factors is recorded in the higher productivity locations, the stands subjected to the research being superior in terms of productivity (production classes I and II), and the increase losses due to the disruptive factors are much greater in the case of the two 60-year-old stands.

All in all, the negative influence of biotic and abiotic factors has increased in light of the increasing artificialization of forest ecosystems due to the creation of monocultures of spruce, by plantations, at the expense of the more stable natural regeneration, in which the proportion of the natural species is much better directed by the laws of nature. For the future, the creation of mixed and far more environmentally stable and economically productive stands, with local genetic material, is in order.

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