THE FUNCTIONAL ROLE OF PRIMARY PRODUCTION IN CARBON CYCLE - ANNUAL BALANCE

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Abstract

The global warming associated to the changes of the precipitations levels and areas are important aspects researchers focus on nowadays. It is well known that one of the causes generating the climatic problems we are confronting with today is the increasing of atmospheric CO_2 concentration and one way to decrease this concentration is to accumulate and store it through vegetation cover. On the one hand the rate of carbon accumulation through photosynthesis and storage capacity is dependent on the percent of areas covered with vegetation and, on the other hand, on the type of vegetation.

The most efficient zones are those with complex plant communities, forest areas for example.

The vegetation carbon storage is dynamic. The main processes that influence the rate of the carbon are the photosynthesis (the carbon is embedded in plants) and the litter decomposition (the carbon is released). There is a small fraction of carbon that passes to the herbivores which was not taken into consideration in this paper for the annual budget estimation. The difference between the accumulations of carbon and the release calculated for one year represents the annual budget.

The annual carbon budget estimated for selected sites was positive, all the plant communities studied being efficient for carbon storage, the most efficient being the structures with a high value of the budget. We compared five types of vegetation M – Meadow, P1 – shrubs, P2 and P3 young forests with heterogeneous herbaceous layer, and S – mature forest with homogenous herbaceous layer. The most efficient vegetation structure for carbon accumulation and long term storage was the young forest zones (P2 and P3) which have a great productivity while the great storage capacity was found in S, the mature forest site.

Keywords: carbon storage, forest, grassland, horizontal structure, litter decomposition, vertical structure

Rezumat
ROLUL FUNCȚIONAL AL PRODUCĂTORILOR PRIMARI ÎN BILANȚUL ANUAL AL CARBONULUI

Modificările survenite în regimul temperaturilor şi al repartiției precipitațiilor la nivel global, în epoca industrială, au făcut ca o serie de fenomene globale cum este de exemplu efectul de seră să preocupe oamenii de ştiință. Studiile acestora au demonstrat că una dintre cauzele amplificării acestui fenomen este creşterea emisiilor de CO_2 în atmosferă. O cale de reducere a concentrației acestuia în atmosferă este mărirea capacității de fixare şi stocare a carbonului atmosferic de către covorul vegetal.

Capacitatea de fixare şi stocare a carbonului din CO_2 atmosferic în vegetație depinde atât mărimea suprafețelor acoperite cu vegetație, cât şi de tipul de vegetație. Eficiența cea mai mare în fixarea şi stocarea carbonului din CO_2 atmosferic o au zonele cu complexitatea structurală cea mai mare, de tipul pădurilor. Stocurile de carbon din vegetație sunt dinamice, existând o permanentă alimentare a acestora prin procesul de fotosinteză şi o permanentă diminuare prin procesul de descompunere. Diferența dintre cantitatea de carbon ce alimentează anual stocurile de carbon din vegetație prin fotosinteză şi cantitatea anuală de carbon cu care se diminuează stocurile de carbon din vegetație, prin procesul de descompunere reprezintă bilanțul anual al carbonului la nivelul - vegetației. Bilanțul anual al carbonului realizat pentru tipurile de vegetație ale zonelor luate în studiu a fost pozitiv, deci structurile respective au avut un anumit grad de eficiență în fixarea şi stocarea carbonului, acesta fiind cu atât mai mare cu cât valoarea bilanțului a fost mai mare. Comparând 5 tipuri de vegetație (M păşune, P1 tufăriş, P2 şi P3 păduri tinere cu strat ierbos foarte heterogen şi S pădure matură cu strat ierbos omogen) având structuri diferite, s-a constatat că eficiența (bilanțului anual al carbonului) cea mai mare este în cazul pădurilor tinere cu structură complexă, ce se află în stadiul succesional ce nu a atins încă climaxul, deşi stocul existent din anii anteriori cel mai mare este în pădurea matură S.

Cuvinte cheie: sdtocul de carbon, pădure, fâneață, structură orizontală, descompunerea litierei, structură verticală

1. INTRODUCTION

Before the industrial and agricultural revolutions, humans had relatively little impact on the global cycling of carbon. But with increased industrialization and agricultural development, human's activities began to play a more significant role in some of the natural cycles. The cumulative effect of this annual anthropogenic sources superimposed on the natural exchange, and the role of anthropogenic sources in increasing atmospheric CO_2 concentrations, must be understood before the effect of CO_2, on climate can be evaluated (Trabalka, 1985). The earth's climate may currently be undergoing a warming in response to the well-documented accumulation of CO_2 and other greenhouse gases. Changes in forestland areas and biomass are playing a role in the accumulation. The temperate forests are roughly in carbon balance, with biomass growth equalling or exceeding losses (Sedjo, 1991). Air and soil pollution provide a synthesis of current research on the carbon cycle, CO_2- sinks and associated processes and fluxes and critical research needs to assess the potential role of forest and land -use management in carbon sequestration (Dowing and Cataldo, 1992). The related aim of carbon cycle research is to provide information for estimating the climatic, indirect and direct, effects on vegetation (Olson, 1985). The terrestrial carbon cycle is complex: the net sequestration of carbon by ecosystem is not only determined by plant photosynthesis, but also by the release of carbon through respiration and decomposition. Each land-cover type has a characteristic Net Primary Production (NPP) limited by structure of vegetation adjusted for local condition (soil, climate) and global atmospheric conditions. NPP is partitioned over the different parts of plants (leafs, branches, trunks, stems, roots) each living a different longevity. The Net Ecosystem Productivity (NEP: the rate of C taken up or released by an ecosystems) is thus a function of NNP and decomposition litter in the soil.

Decomposition occurs over a period of time resulting in carbon flux to the atmosphere (Leemans, 1996). An important problem is to identify structural parameters necessary to -sort out different vegetation types and to estimate C fixation capacity. A major focus of vegetation research is the search for consistent structure and identification of the mechanism that generate it. (Noy-Meir and Van Der Maarel, 1987; Wilson and Sykes, 1988; Drake, 1990; Wilson, 1991).

Vegetation structure may be defined to include texture, horizontal pattern, vertical pattern and co-accuracy pattern (association) (Van der Maarel, 1988), and represent most important parameters. Texture is the qualitative and quantitative composition of the vegetations to different morphological elements (Barkamar, 1979). The association is a fundamental unit of the hierarchy, unit that corresponds in function to the species s the fundamental unit of idiotaxonomy, or the classification of individual organisms (Whittaken, 1978).

The vertical structure represented by vegetation layering is an important structural character. Mostly only three principal layers are distinguished as the trees, shrubs and herbs (Whittaken, 1978). In the description of horizontal structure an important -parameter is species richness (inventory of taxa). Annual/biannual plants, perennial plants report reflect stability of vegetation community. Cover degree and abundance are usually esteemed together in a single „combined estimation" or „cover-abundance scale" is necessary in dominants species choice (Whittaken, 1978).

The aim of this work was to investigate if different vegetation structures, in the same climatic conditions, play a different role in C cycle. What vegetation structure is more efficient in fixing and to stocking C? What structural parameters can be use to characterise different structures with different role in carbon cycle?

2. MATERIAL AND METHODS

Study area: The study, lasted from summer 2000 until autumn 2003, was conducted in a site parallel to the Glavacioc stream (an ecotonal zone between an wetland area and an agricultural field) ($44^0$27'41" – $44^0$27'47"N, $25^0$16'36" -

25⁰16’46”E), (with an area of 6350 m^2).

The climate of region is characterized by cold winters (January average temperature –4.52⁰ C) and warm summers (July average temperature 21.1⁰ C). The mean annual precipitation of 480 mm, to 700 mm falls as rain mainly between March and November. This area is divided in three zone distinguished by vegetation type. The first zone (M) is represented by grassland and the other zones are two forested zones (P with slow slope and S with high slope)(fig. 1).

Aboveground structure, biomass production and productivity in grassland and herbaceous layer in forest were determined by sequential sampling (0.25 m^2 for each 10 quadrate plots, five times per year, located random). Three floristically releves per year (one in spring before the growing season start, one in summer in the period of maximum standing crop and one in autumn) were necessary to identify species richness and to esteemed biomass and productivity. For each quadrate all species were inventoried, estimated the cover degree-abundance. Using Braun-Blanque scale compared with cover-abundance scale of DOMIN (Evans and Dhal, 1955) was identified dominant species.

The dominant species were considered species with a cover degree-abundance up 2. Similarity Jaccard index was calculated using equation:

$$Jq_J = \frac{c}{a + b}$$

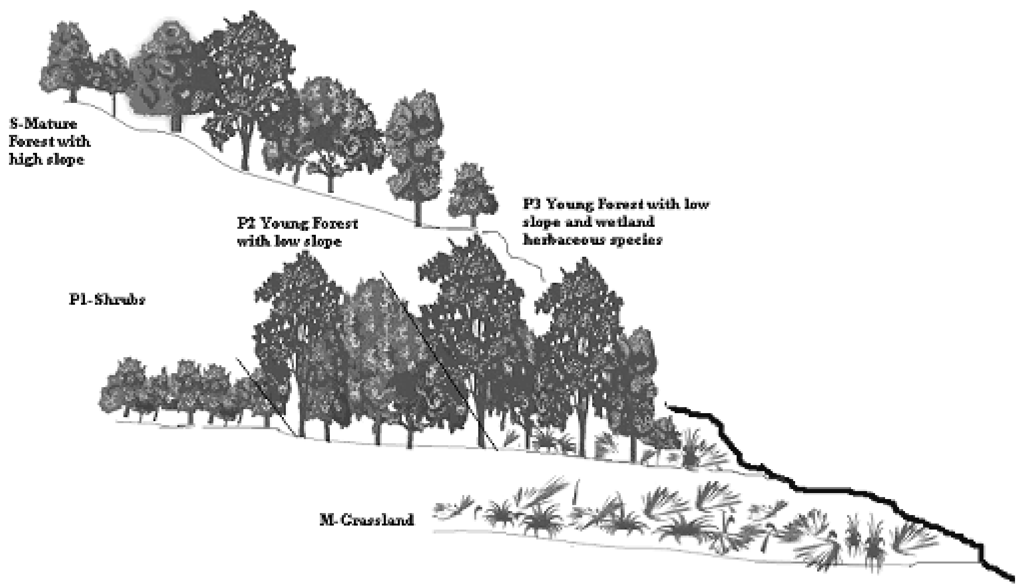

Fig. 1. Vegetation types in Glavacioc site
Tipurile de vegetație studiate în Glavacioc

where: a - number of species present in zone A, b - number of species present in zone B, c - number of species in commune in zone A and B (Botnariuc and Vădineanu, 1982).

Above-ground biomass was sorting in dead and living material and draying at 70⁰C for 48 h. Significant increases or decreases in dead and/or live biomass between sampling dates make up productivity according to the flowing decision rules (McClaugherty et al., 1982):

Live biomass	Dead biomass	Productivity
Increase	Increase	$\frac{dLiving + dDead}{dt}$
Increase	Decrease	$\frac{dLiving}{dt}$
Decrease	Increase	$\frac{dLiving + dDead}{dt}$ or 0
Decrease	Decrease	0

Below ground biomass and productivity. Were collected five root cores (one in each quadrate); 15 cm depth using a root corer with a diameter of 16 cm. Material was separated in living and dead roots visually and after drying for 48 h at 70⁰C was weighting.

Shrub sampling. For the shrub layer we selected ten sample plots in the P zone. The size of these quadrates was 9 m^2. For each shrub species stem present in each quadrate was measured diameter and height, some was shorted to determine volume and dry weight.

Biomass, production and productivity in forest. For all trees present in forests P and S was measured total height and diameter at breast height (BHD, 1.3 m) with dendrometer apparatus and a steel diameter tape. We used dendrometrical tables with double entrance (total height and diameters of trees) for each species was estimated volume of the stems, branches, bark and roots (Giurgiu, 1972). Biomasses of the stems, branches, bark and roots were determined as the product of volumes and wood species gravity.

Five groups of three dominant species trees were selected in each zone. One tree with a diameter closest to the mean diameter was selected per group as well as two trees of within +/- SD. For each trees selected was uptake five replicates fresh leaves samples and tow samples with increment cores for growth analyses and age determination. Using the following equation (Mitsch, 1991) was calculated basal area increase (*Ai*):

$$Ai = \pi * [r^2 - (r-i)^2]$$

where: *r* - radius of tree at breast height; *i* - mean radial increment per year (when cores are taken this can be based on the last five years).

Annual stem production per tree (Pi) was calculated following Whittaker and Woodwell method (1968):

$$P_i = 0.5\ \rho\ A_i\ h$$

where: ρ = wood specific gravity

h = tree height

Stem productivity for all trees in area was calculated following equation:

$$\text{Pw} = \Sigma\ [\text{Pi}]^* \frac{BA}{Bc}$$

where: Pw = site stem productivity

BA = average basal area per m^2 of ground area calculated for the site

Bc = total basal re of the cored trees

Measurement of litter fall. 10 litter traps with hoops of 0.5 cm in diameter are placed randomly along transect parallel to the stream, at 1.5 m above ground level. Litter was sampled fortnightly in spring an autumn and monthly in summer and part of winter.

The decomposition was measured as weight-loss from litter bags method.

Five replicates were taken per zone at six sampling moments: 1.5 months, 3 months, 6 months, 12 months, and 24 months. The size of litterbags was 10*10 cm by polythene with mesh size 0.3 mm. The annual decomposition constant " k" (Oslon, 1963) for the exponential relationship was calculated, using the equation:

$$\ln\left(\frac{x_0}{x_t}\right) = kt$$

where: x_0 is the original amount of litter, x_t is the amount of litter remaining after time t (days), K values were calculated by linear regression of $ln\ (x_0/\ x_t)$ vs. time. Total C content in all plants samplings was analysed by sulphochromic oxidative - NF X31-109 (1994) – method and CHN analyser.

3. RESULTS AND DISCUSSIONS

Regarding the temperatures and precipitations, the 2001 year was unusual. The summer mean temperature (27.8^{0}C) was higher than the normal one (21.1^{0}C) and the rain falls (373 mm) lower than the normal quantities for temperate climate of the area (Table 1).

Despite the great range of temperatures and precipitations measured during the year, we did not recorded important modifications of the structural parameters of plant communities, specific diversity being one of the important parameters easy to monitories.

The highest specific diversity was recorded in the forested area S although the herbaceous layer was homogenous comparing to the forested area P where due to the heterogeneity of the site we split the area into the three parallel zones.

In this ecotonal area of about 380 m length and 30 m width we recorded high species diversity. We have found different dominant species for each site selected for study. The herbaceous layer species, mainly from site P pointed out the humidity gradient of the soil. In site S, dominant species are ruderal species underlining the anhtropic influence in the area (Table 2).

Analyzing the Jaccard similarity between the sites as it can be seen in the Figure 2, the selected sites are different from the point of view of species richness. Less than 20 % of the species are common species for all three sites. A higher similarity was found between the forested sites (P and S) but the common species are about 30%.

The highest biomass values for above and below ground vegetation were recorded in august. Comparing the three sites, the most productive zone was P3 followed by S site. The less productive taking into consideration both above and below-

Table 1. Monthly temperatures and precipitations in Glavacioc site, year 2001
Temperatura si precipitațiile lunare în anul 2001, în Glavacioc

Months	Mart.		Mai		June		Aug.		Oct.	
Temperature (ºC)	min	Max	min	Max	min	Max	min	Max	min	Max
	6	12	10	24	15	32	20	42	11	29
Precipitation (mm)	69.6		98.7		65.2		46.3		63.8	

Table 2. Type of vegetation, dominant species and species richness in the selected sites from Glavacioc
Tipurile de vegetație, speciile dominante şi bogăția specifică în arealul selecatat din Glavacioc

Site		Type of vegetation	Number of layers	Dominant species	Species richness
M		Meadow	1:Herbaceous layer	*Lolium perenne* *Taraxacum officinale* *Trifolium repens*	44
P	P1	Shrubs	2: Herbaceous and shrubs layer	*Buglossoides purpurocaerulea* *Cornus sanguinea* *Rosa canina* *Crategus monogyna*	55
	P2	Forest	3: Herbaceous, shrubs and trees layer	***Ranunculus polyanthemos*** *Fraxinus excelsior* *Populus alba*	
	P3	Forest	3: Herbaceous, shrubs and trees layer	***Carex riparia*** ***Scyrpus sylvaticus*** *Fraxinus excelsior* *Populus alba*	
S		Forest	2: Herbaceous and trees layer	*Lamium purpureum* *Geum urbanum* *Quercus robur* *Acer campestre*	63

ground biomass was site P1. A high productivity was found in the meadow (M) due to the higher turnover rate (table 3).

In most of the cases the report between the aboveground biomass and below ground biomass for herbaceous layer was subunitary, showing the aridity trend in the area (fig. 3).

The biomass values range between 1531dry weight g/m^2 and 25 dry weight g/m^2, both values being according to the literature data for herbaceous layer (table 4).

The highest value of herbaceous biomass for all the sites were recorded in august. Therefore we estimated the biomass values for all the layers (shrubs and trees) for the same month. The total biomass of the sites increased from the meadow M to the forested site S where we recorded a value of about 28.5 times higher comparing to the meadow (table 5). Although the Jaccard similarity between P and S is high (> 80%) the total biomass in S was 3.5 times higher comparing to the average value for site P. Comparing the herbaceous productivity values for the three sites, the lowest value was found in site S and the highs value in site M (the meadow) (Table 6). Comparing the

Table 3. Above -ground and below- ground biomasses in herbaceous layer
Biomasa suprateranǎ şi subteranǎ a stratului ierbos

		Site	Aboveground biomass (g s.u/m^2)					Belowground biomass (g s.u/m^2)				
			March	May	June	Aug.	Oct.	March	May	June	Aug.	Oct.
M		Live biomass	121	186	232	282	170	426	518	593	624	487
		Dead biomass	4	10	8	4	14	32	3	15	47	78
		Total	**125**	**196**	**240**	**286**	**184**	**458**	**521**	**608**	**671**	**565**
P	P1	Live biomass	22	80	92	121	53	63	124	216	242	187
		Dead biomass	3	7	4	2	19	35	42	71	57	97
		Total	**25**	**87**	**96**	**123**	**72**	**98**	**166**	**287**	**299**	**284**
	P2	Live biomass	20	29	45	100	52	84	465	681	713	706
		Dead biomass	6	9	4	14	26	23	33	102	180	184
		Total	**26**	**38**	**49**	**114**	**78**	**107**	**498**	**783**	**893**	**890**
	P3	Live biomass	134	460	624	667	639	406	1015	1267	1486	1285
		Dead biomass	5	13	3	2	26	14	39	148	193	137
		Total	**139**	**473**	**627**	**669**	**665**	420	**1054**	**1415**	**1531**	**1422**
S		Live biomass	114	172	193	298	105	254	503	679	806	792
		Dead biomass	2	7	4	2	22	31	95	88	120	111
		Total	**116**	**179**	**197**	**300**	**127**	**285**	**598**	**767**	**926**	**903**

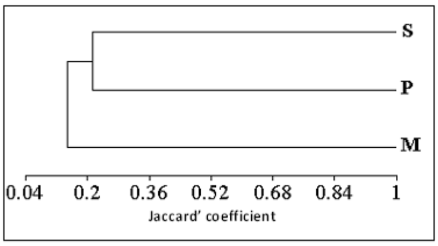

Fig. 2. Jaccard similarity between M, P and S zones
Indicii de similaritate Jaccard pentru tipurile de vegetaţie M, P şi S

sites P and S, the differences between the productivity can be explained by the fact that site S is a mature forest (with trees about 73 cm diameter) while in the forested site P trees has about 41 cm diameter (fig. 4). Therefore, the low herbaceous productivity in site S is associated to high species diversity (66 species comparing to 55 species in site P) and is compensated by the high productivity of the trees layer.

Regarding the carbon storage in the vegetation cover, the values follow a similar trend to the biomass, the carbon concentration per dry weight biomass being about 50% (table 7).

Both, the biomass of the vegetation cover and the carbon stocks are dynamic. The dynamic is related to the productivity of the vegetation cover (the input of the C into the ecosystem) and the litter decomposition (the release of the C). A high stock of the C can be found in the trees and shrubs stems and roots.

The accumulation rate of the carbon has the same dynamic as the vegetation biomass accumulation (about ? for the primary productivity)(table 8).

Since the carbon storage into the stems and roots for multiannual plants is long time storage for the annual balance of the carbon we considered that this fraction of carbon is sequestered for a long time period. The main release way of the carbon is the litter decomposition, and taking into consideration the above mentioned we estimated only the leaves litter decomposition.

The decomposition rate values are presented in table 9. The highest decomposition rate for herbaceous layer was found in site M, decreasing slowly towards site P (k= 2.05g x 10-1/m^2/day for aboveground respectively k= 2.36g x 10-1/m^2/day foe belowground) and S. The same trend was found for trees leaves

Table 4. Biomass of herbaceous layer according to different authors
Biomasa stratului ierbos după diferiţi autori

No.	Type of biomass	Authors	Values (g s.u./m^2)	Years
1	Belowground	Hogg	1547	1987
2	Aboveground	Paucă-Comănescu	32.34	1989
3	Aboveground	Veer	517-777	1997
4	Belowground	Veer	155-1001	1997

Table 5. Biomass of herbaceous, shrubs and trees (litter and stem) layers
Biomasa stratului ierbos, arbustiv şi arborescent

Site	Zone	Biomass (dry weight g./m^2)					
Glavacioc		Herbaceous layer aboveground	Herbaceous layer belowground	Shrubs layer	Trees stem	Litter	**Total**
	M	286 ± 19	671 ± 15	-	-	-	**958**
	P1	123 ± 12	299 ± 16	944	-	185	**1551**
	P2	114 ± 18	893 ± 20	165	8429	458	**10059**
	P3	669 ± 22	1531 ± 31	165	8429	458	**11252**
	S	300 ± 25	926 ± 28	-	25770	323	**27319**

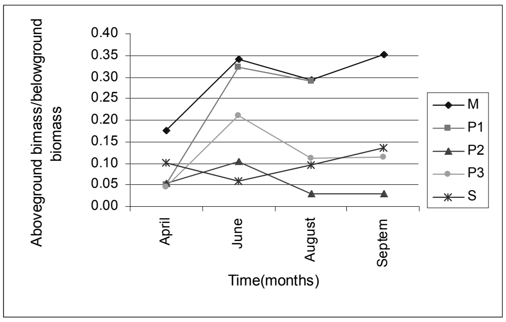

Fig. 3. The ratio reported between the above-ground biomass and below-ground biomass for herbaceous layer.
Raportul biomasă supraterană şi subterană pentru stratul ierbos

decomposition (table 9). The carbon release rates due to the decomposition process have a similar dynamic and the values are presented in, content of carbon in the litter is almost 50% (table 10).

Comparing the sites from the point of view of the carbon storage capacity, we can conclude that the most efficient site is P3 (a forested area in a young stage, with a high productivity)(table 11, 12).

4. CONCLUSIONS

The decrease of the CO_2 concentration in the atmosphere is a priority nowadays, since it is incriminated as one of the most important gas producing of the greenhouse effect. Besides the economical measures that should be taken another important step is increasing the areas covered by vegetation associated to the maintaining of some types of vegetation. The capacity of different types of vegetation structures to accumulate and embed the atmospheric CO_2 is close related to structure and dynamic of vegetation.

The high complexity of vegetation structure is (number of layers, species richness etc), the higher is the capacity of carbon storage. The successional stage of the plant communities is also important, and we have found that different accumulation rates are associated to different stages. Therefore, the forested site P, characterised by plant communities in an earlier successional stage than forested site S, has an annual accumulation rate higher although the existent carbon stock from S site is higher.

We can conclude that the most efficient vegetation communities for accumulation and storage of carbon are young forested areas. Their structure is stable enough and they have a high productivity. The meadows are characterised by a lower storage capacity and a great dynamic. The meadows productivity is high but the storage capacity is reduced, most of the carbon embedded during the vegetation season being released through litter decomposition. For ecological reconstruction of different types

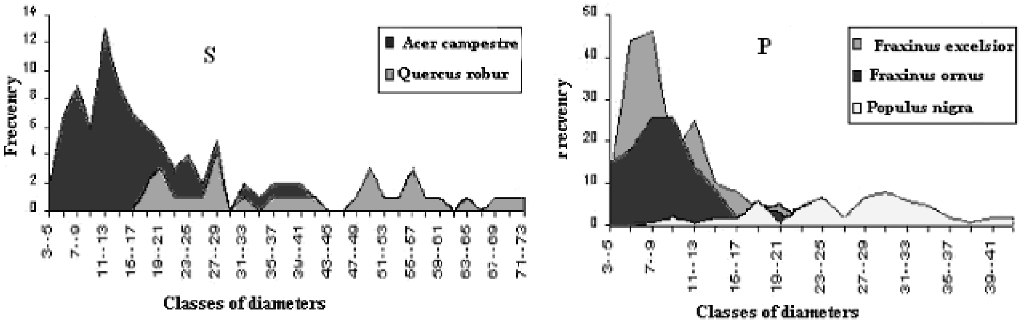

Fig. 4. Distribution of trees on diameter classes in sites S and P
Distribuţia arborilor pe categorii de diametre pentru S şi P

Table 6. Productivity of herbaceous, shrubs and trees (stem) layers
Productivitatea straturilor ierbos, arbustiv şi arborescent

	Zone	Productivity (g dry weight./m^2/day)		Productivity (g dry weight./m^2/year)	
		Herbaceous layer aboveground	Herbaceous layer belowground	Shrubs layer	Trees stem
Site Glavacioc	M	0.69	1.01	-	-
	P1	0.42	0.89	113	-
	P2	0.38	3.24	90	1162.60
	P3	2.22	5.18	90	1162.60
	S	0.61	2.67	-	1372.34

Table 7. Carbon stock of herbaceous, shrubs and trees (litter and stem) layers
Stocul de carbon în straturile ierbos, arbustiv şi arborescent

	Zone	Carbon stock (g C./m^2)					
		Herbaceous layer aboveground	Herbaceous layer belowground	Shrubs layer	Trees stem	Litter	**Total**
Site Glavacioc	M	120.3	290.6	-	-		**410.9**
	P1	48.4	132.7	463.9	-	81.8	**726.8**
	P2	46.1	422.2	41.2	4181.6	222.9	**4914**
	P3	289.2	779.5	41.2	4181.6	222.9	**5514.4**
	S	124.6	421.8	-	12961.8	152.4	**13660.6**

Table 8. Accumulation rate of carbon in herbaceous, shrubs and trees (litter and stem) layers
Rata acumulării carbonului în straturile ierbos, arbustiv şi arborescent

	Zone	Accumulation rate (g C/m^2/day)		Accumulation rate (g C/m^2/year)		
		Herbaceous layer aboveground	Herbaceous layer belowground	Litter	Shrubs layer	Trees stem
Site Glavacioc	M	0.285	0.455		-	
	P1	0.167	0.398	81.8	55.5	
	P2	0.151	1.536	222.9	43.7	576.8
	P3	0.915	2.367	222.9	43.7	576.8
	S	0.251	1.229	152.4		690.2

Table 9. Litter decomposition rate for herbaceous and trees layers in selected sites
Rata de descompunere a litierei straturilor ierbos şi arborescent în situl studiat

Site	Zone	Decomposition rate in herbaceous layer -k (g X $10^{-1}/m^2$/day) aboveground	Decomposition rate in herbaceous layer -k (g X $10^{-1}/m^2$/day) belowground	Decomposition rate in leave of trees -k (g X $10^{-1}/m^2$/day)
Glavacioc	M	2.65	5.37	-
	P1	2.12	2.98	0.87
	P2	1.83	2.12	1.14
	P3	2.20	1.97	0.93
	S	1.38	1.88	0.35

Table 10. Remove rate of carbon in decomposition process (K), in herbaceous and trees (litter) layers
Rata de eliberare a carbonului în procesul de descompunere a vegetației din straturile - ierbos şi arborescent

Site	Zone	Decomposition rate -k (g C X $10^{-1}/m^2$/day)		Decomposition rate -k (g C X $10^{-1}/m^2$/day)
		Herbaceous layer aboveground	Herbaceous layer belowground	Litter of the trees
Site Glavacioc	M	0.97	2.25	
	P1	0.79	1.21	0.36
	P2	0.76	0.79	0.48
	P3	0.92	0.73	0.38
	S	0.56	0.87	0.16

Table 11. Annual carbon balance in herbaceous and trees litter (components with high cycle rate)
Bilanțul anual al carbonului pentru straturile ierbos şi arborescent

Site	Zone	Carbon stock in vegetation (herbaceous and litter) (g C/m^2)	Carbon supply in the vegetation season (herbaceous and litter) (g C/m^2)	Carbon annual release in decomposition process (herbaceous and litter) (g C/m^2)	Carbon annual accumulation in herbaceous and trees litter (g C/m^2)
Site Glavacioc	M	**1632.8**	136.2	117.53	18.67
	P1	**1695.4**	104.0	86.14	17.86
	P2	**1831.9**	310.4	74.095	236.3
	P3	**1921.4**	603.9	74.095	529.8
	S	**1815.9**	272.3	58.035	214.2

Table 12. Annual carbon balance in all vegetation layers
Bilanțul anual al carbonului pentru tipurile de vegetație studiate

Zone	Carbon annual accumulation in herbaceous and trees litter (g C/m^2)	Carbon annual accumulation in shrubs layer (g C/m^2)	Carbon annual accumulation in steam of the trees (g C/m^2)	Carbon annual accumulation in all layers (g C/m^2)
M	18.67	-	-	18.6
P1	17.86	55.5	-	73.3
P2	236.3	43.7	576.8	856.8
P3	529.8	43.7	576.8	1150.3
S	214.2	-	690.2	904.4

of zones is recommendable to create forested areas and the evolution of these areas to be directed to mature successional stages.

The quantity of carbon stored in the vegetation is dynamic, being influenced mainly by two processes: accumulation through photosynthesis and release through litter decomposition. The difference between the carbon embedded and carbon released by the two processes mentioned above during one year represents the annual budget of the carbon. For all the sites the annual budget was positive, the most efficient area being site P3 and the less efficient area the site P1. On a scale for the carbon storage efficiency after the shrubs area considered the less efficient follow the meadow area, the mature forested area, the high efficient area being the younger forested site.

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