Green Infrastructure - An Important Factor in the Preservation and Use of Biodiversity to Reduce Diffuse Pollution and Production of Biomass

Iuliana Florentina Gheorghe, Ion Barbu

Abstract- Presently the European Union countries are confronted with the need for development, the increase of living standards involving an increased use of resources and energy, and also an increase of pollution. Natural and semi-natural ecosystems are the main sources in the production of resources and energy generation. With the increase in the amount of required resources and energy the human pressure exerted on ecosystems and biodiversity is higher, which implies the need for preservation of these species and ecosystems. Residues arising from the use of resources that emphasize forms of pollution accentuate the anthropogenic pressure on natural capital.

Keeping a mosaic structure is an ideal solution to harmonize the development of society with nature conservation. A green infrastructure with lakes and rivers, wetlands, different types of forest, pastures, shrubs including different types of crops, represents the ideal structure to meet both goals.

Key Word- Type of vegetations, Primary production and productivity, C stocks, N stocks, C and N uptake

I. INTRODUCTION

Europe's agricultural sector has received support Policies (CAP) over the last 50 years. This support has evolved alongside growing recognition and awareness of the strong links between agricultural production and biological diversity conservation. On one hand, it was recognized that changing agricultural land use is a decline of biodiversity in major cause of the Europe.

Whereas on better land farming systems have generally intensified, poorer land has been subject to abandonment or afforestation. Traditional, low-intensity farming systems with high nature value have gradually and steadily disappeared (EEA, 2009a). On the other hand, maintaining biodiversity makes agricultural production and related practices both more sustainable and more cost-effective. Biodiversity and agricultural production are inextricably interlinked and their capacity to be mutually supportive is increasingly recognized. Unfortunately, despite recognition of agriculture's heavy impact on nature, the agricultural policies, particularly common agrarian policy of the EU (PAC) is not changing sufficiently to reduce biodiversity loss (EEA, 2009 a).

Manuscript received March 15, 2014.

Iuliana Florentina Gheorghe, Ecological University of Bucharest, Faculty of Natural Science and Ecology,Bd. Vasile Milea 1G, Bucharest, Romania

Ion Barbu, Forest Research and Management Institute, Research Station for Norway Spruce Silviculture Câmpulung Moldovenesc, Calea Bucovinei 73 bis, Câmpulung Moldovenesc, Ro-5950, Romania

In several EU countries, direct support is provided on a historic basis, which in practice favors more productive land, usually farmed intensively. Moreover, cross-compliance rules can only make a small contribution to biodiversity conservation because although they limit environmentally damaging practices, they cannot really ensure active management of ecosystems rich in biodiversity. Agriculture is the dominant land use for approximately 50 % of the land area in the EU-27. As such, it is a key influence on the environment in Europe, including soil and water resources, biodiversity and landscape as well as greenhouse gas emissions (e.g. EEA, 2006 b). It is also an important economic sector in many rural areas of Europe, and one that is diversifying beyond food production. The production of renewable energy and biomaterials is beginning to be a significant source of income for farmers in Europe. Due to changes in the production and consumption of food in Europe, agriculture has the potential to be a major contributor to bio-energy production in the EU-27. Thus, it can support the efforts to significantly increase the share of renewable energy sources in total energy production in the EU. At the same time the shape and intensity of the agricultural sector determine the likely success in reaching environmental objectives of the European Union. This relates to the management of the Natura 2000 network of protected sites for biodiversity, the water quality targets included the Water Framework and Nitrate Directives as well as the ammonia reduction targets of the National Emissions Ceilings (NEC) Directive, to name just a few (EEA, 2006a). Can the aim of substantially increasing bio-energy production from farmland be achieved without compromising other environmental objectives at the EU level? What conditions need to be met for additional biomass production on farmland to remain environmentally compatible? Currently, around 4 % (69 MtOE) of the EU's total primary energy consumption is met from biomass. This makes biomass by far the most important renewable energy source, providing two thirds of the total energy produced from renewable (Eurostat data). Agricultural intensification and land abandonment are the two main trends affecting the species and habitats that depend on low intensity farming in Europe. Mechanization, drainage, introduction of irrigation crops, loss of fallow fields and increased use of agro-chemicals are main features of agricultural intensification. Land abandonment causes the loss of specialized species and the replacement of low intensity agro-ecosystems with successions of less rich and diverse vegetation or afforestation [1]. Mechanization and intensification of Europe's farming practices has not only affected a wide range of farmland habitats and associated ecosystems but has also simplified the whole agricultural landscape. While farm and field

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

size have increased to allow heavy machinery to move, landscape features such as small woodlands, ponds and hedges have disappeared. Intensive farming systems are also based on genetically uniform crops and livestock breeds, vulnerable to pests and diseases [2]. These low input farming systems all aim to enhance biological soil fertility and the natural capacity to reduce negative effects on agricultural production, such as disease and climatic change [3]. In the context of needing to guarantee stable and affordable food supply (food security) for a growing world population and with increasing demand for biomass to achieve the EU bio-energy targets for 2020, it is difficult to advocate halting agricultural intensification completely on land with high production potential (EEA, 2009 a; [4]. The challenge for biodiversity conservation is therefore to introduce buffering elements into intensely farmed systems that enhance the landscape complexity of the agro-ecosystems and provide a mosaic of habitats for species. Often named 'ecological infrastructure', they include hedges, small ponds, beetle banks and other habitats. Combined with agricultural practices such as long and diverse rotations, more heterogeneous regional distribution of crops and better adjustment to the natural soil fertility, these practices can contribute to enhanced biodiversity while at the same time maintaining a high level of productivity [5], [6]. Green Infrastructure can play an important role in this context. Aims of this paper is to quantify the importance of a mosaic structure consisting natural and semi-natural ecosystems in reducing diffuse pollution from agricultural lands by directing excess nutrients to biomass used as bio-fuel.

II. MATERIALS AND METHODS

Using the Action plan for protection of waters against pollution caused by nitrates coming from agricultural sources elaborated by Ministries of Environment and Forests in 2008, we chose to study the area of the Glavacioc catchments (N - 44°27'09"; E - 25°16'32"; elevation – 161 m) because in these papers, it is an important national zone for diffuse nutrient pollution coming from agriculture. This basin was characterized in terms of climatic data, land use, cropping system, soil types, nutrient input, proportion and structure of riparian zone and types of vegetation in riparian zone.

General climate data about catchments was provided by National Institute of Meteorology and Hydrology. Information about the cropping system was taken from National Statistical Yearbook for 2007, Agency Payments and Interventions in Agriculture and the Land Register Book. The soil maps (scale 1:200 000) were purchased from Research Institute of Soil Science and Agro-chemistry. For maps of land use were used digitized maps "Corine land cover 2006", being processed in the ArcView GIS 3.2a. For maps we also used Wikimapia interactive maps and Google Earth web site. Detailed data on the forest area of the study was provided by the Institute for Forest Investigation was done in two steps: field visit and study desk. At the beginning of January we did a field trip with the aim of studying the area selections. After visiting the entire basin we determined that the work in the Glavacioc catchments area and the site that will make the detail researches. To identify the riparian areas we used topographic maps, forest maps, orto photo-plans, Wikimapia maps and field-trips to validate the information present in the maps. Depending on the degree of representation we chose five types of riparian vegetation: wetland with *Carex sp. Lythrum sp., Scyrpus sp.,* pasture, mixed forest, forest with *Quercus* species (Querceta) and wheat crop. For each zone we estimated: structure of vegetation, dominant species, biomass, primary productivity, C, N stocks and C, N uptake. In order to determine the species composition, we did one floristical survey in July 2010, during the peak of the vegetation seasons. To establish the dominant species we used the Braun- Blanquet method (Whittaker, 1978). To estimate herbaceous biomass was established five plots, randomly distributed, with the size of each plot being 0.25 m^2 (quadrates method, [7]. In each plot we identified the plant species, height of the vegetation, cover degree and the aboveground and belowground biomass. Aboveground and belowground biomass was determined by sorting dead and living material and drying it at 70° C for 48 h. The herbaceous layer productivity was assessed using the McClaugherty method [8]. Belowground productivity: We collected five root cores (one in each quadrate); 15 cm depth using a root corer with a diameter of 16 cm [9], [10]. Material was separated in living and dead roots visually and after drying for 48 h at 70° C and then weighed. To identify and select the typology and types of forest we used the arrangement study and trips in the field to validate the information present in the arrangement study. The typology has been established accordingly: the species composition, total height of the trees, HDB, age of the trees, spatial density of the trees, and quantity of the wood/ha and productivity. The typologies are organized in forest types according to dominant tree species.

For the two types of the forest (mixed and with different *Quercus* species -Querceta) the study was conducted in five circular zones, four located on the four cardinal directions at 100 m distance from one another, and another at the intersection of diagonals. For the trees layer, in the sample surface, we inventoried all trees, measured the diameter at 1.3 m (HDB) and overall height for each tree. On HDB and tree height, with double-entry dendrometrical tables we estimated the wood volume for each tree species. Depending on volumes of wood and wood density we calculated the wood biomass. Stem productivity was estimated according to Whittaker and Woodwell (1968) as biomass accumulated per area and time unit [11]. For each plot, one individual tree of average diameter was selected for each of the three dominant species. Stem cores were harvested in two replicates for productivity, growth and age determination. Basal increase area was calculated according to Mitsch (1991) as:

$$A_i = \pi [r^2 - (r-i)^2] \quad (1)$$

where r is tree radius at 1.3m height and i is the mean across five years of the annual radial increment [12]. Annual stem productivity Pi was calculated as:

$$P_i = 0.5 \rho A_i h \quad (2)$$

where ρ is wood specific density and h is the tree height [11]. Site stem productivity PW was calculated as:

$$PW = \Sigma [P_i] BA/BC \quad (3)$$

where BA is the average basal area / m^2 for the given site and BC is the total basal area of the samples trees. The growth cores taken with Pressler increment borer were dried and ground. For the herbaceous layer in each 500 m^2 we establish five plots, randomly distributed, size of each plot was 0.25 m^2. In each plot we identified the plant species, height of the vegetation, cover degree and we took the aboveground and belowground biomass. Aboveground and belowground biomass was dried and ground**.** The herbaceous layer productivity was assessed used the McClaugherty method. Leaf biomass of the trees was estimated used LAI method. The N and C content were determined using the CHN analysis method.

III. RESULTS AND DISCUSSION CLIMATIC DATA

The Glavacioc basin is an area moderate in precipitation; the average is over 500 mm and monthly average temperatures between -4 °C and 26° C. The dynamic of temperatures in the last four years were similar, increasing from winter to summer and decreasing from summer to winter following the same trend (fig. 1 a). The last two years have been atypical in terms of precipitation; the dry months of 2009 were rainy months in 2010. The biggest difference was recorded in August when in 2009 there were floods and drought in 2010 (fig. 1 b).

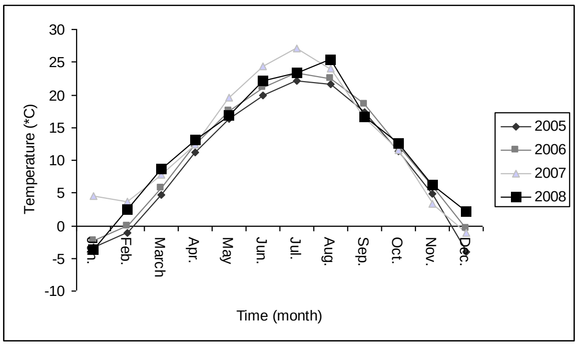

Fig. 1 a Dynamic of temperatures in the last four years

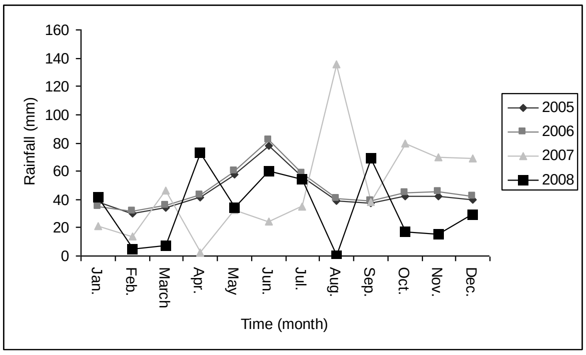

Fig. 1 b Dynamic of rainfall in the last four years

Relative humidity recorded at the meteorological station in the center of the basin was 72% (annually mean values). Annually potential evapo-transpiration varied between 598 mm and 718 mm. During winter (between December and February) evapo-transpiration value was "0". The highest value of evapo-transpiration was registered in June (average between 143 mm/month and 147 mm/month). Regarding nebulosity, the number of clear days was 125, with 117 days of cloudy sky and 123 days of covered sky.

LAND USE

In the Glavacioc river basin the following types of ecosystems are present: wetland, villages and rural areas, forest, agricultural land, rivers and lakes (fig. 2). About ¾ of the Glavacioc's basin area is covered with agricultural land (71.5%). In the past, in this area has been practiced intensive agriculture using the large amounts of artificial fertilizers. For these reasons, this area was one of the most susceptible to nutrient pollution in Romania. The natural vegetation, representing riparian area, located on the riverbank is an important buffer zone that has been investigated. Except for agricultural land, most of the land is covered with various constructions, (13%) representing the rural area consists of villages. The forests occupy 12% of the territory, wetland 2%, pasture 1%, rivers and lakes 0.5%. Although the forest area is not very large, there is a great diversity of types of forest. Dominant tree species are species of the genera *Quercus*, *Salix, Populus, Alnus, Acer*, *Ulmus, Fraxinus*, etc. 22.4% of this field is present in the riparian zone and covered with these types of vegetation: wetland with *Carex sp. Lythrum sp. Scyrpus sp.* ; wetland with *Salix sp.* and *Typha sp.*, *Scyrpus sp.*; pastures; forests (24 typologies) and crops: wheat (86%), sunflower (3%), maize (11%).

CROPPING SYSTEM

The number of types of crops at the national level is 36, of which 25 (69.4%) are found in the Glavacioc river basin, which represents a great diversity (fig. 3).

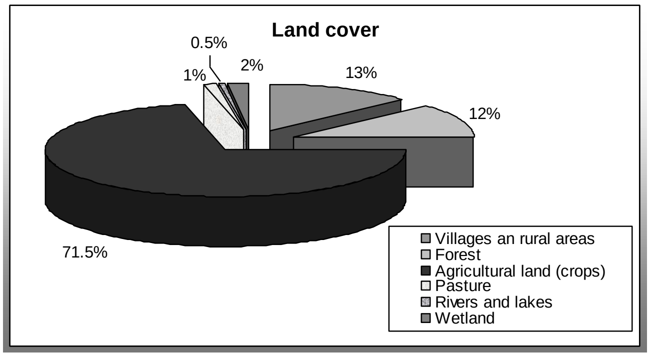

Fig. 2 Types of ecosystems in Glavacioc catchments

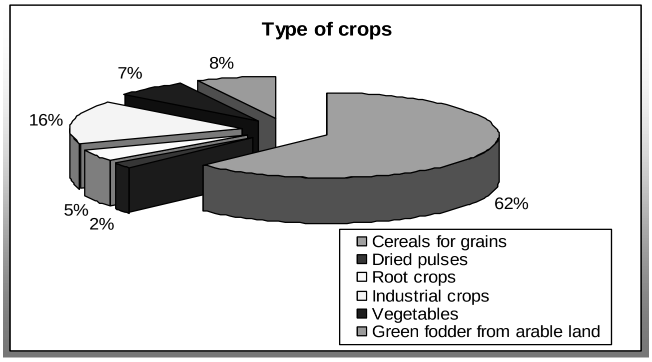

Fig. 3 Type of crops, surface of catchments level

The largest area is occupied by grain cereals, most crops are annual, and the sowing period for most of the cultures is spring. For all type of crops is practiced the fall tillage mechanized and done by the tractor with high power even if the crop is establish is next spring. It is an area with regular rainfall and rich does not require irrigation. Organic fertilizers (manure) are mainly used and chemical fertilizers are added only rarely. The amount of organic fertilizer per ha used varies between 10 t/ ha and 15 t/ha.

SOIL TYPES

As a result of pedological studies at the basin level the following types of soil have been identified: clayey soils (brown red typical, brown red luvic-vertic, brown red luvic-pseudogleizic) and land bill (cambio-soils) (brown eumezobazic- molic, brown eumezobazic – glezic). Typical red brown soil was identified in areas with southern exposition and slope of 15°-20° which are switching from the meadow to the river terrace. Red brown soil luvic vertic is on terraces and in areas with deficient rainfall. Red brown soil luvic pseudoglezic is present on the plains of average height and river terraces. Molic eumezobasic red brown soil was found in thermopile forests of oak, elm, maple. Gleizat red brown soil was found in the forests of meadow consisting of poplar and willow. In terms of quality about 60% agriculture soils are eroded and 15% leachates [13].

IV. NUTRIENT INPUTS

In Basin of the Galvacioc River there are two sources of diffuse pollution: untreated sewage and fertilizers used in agriculture. Both sources of diffuse pollution create an additional intake of nutrients.

Intake of nutrients using fertilizers Fertilizers are used for three main crops (maize grain, wheat and sunflower), only some of these areas are fertilized. 3% of the cultivated area of grain maize is fertilized with mineral NPK (75 kg N/t, 130 ka P/t and 175 kg K/t) and 10% with organic fertilizer (manure). Surface of the wheat crop fertilized with NPK is about 20% and with the manure 5%. For fertilization of sunflower crops only NPK is used and 30% of cultivated area is being fertilized. Manure comes from raising cows and has a nitrogen content of 5 kg N/t and 0.49 kg P/t (mean values in dry substance). For fertilization with NPK the farmers use between 250 kg / ha and 300 kg / ha, and amount of manure used as fertilizer is between 10 t/ha and 15 t /ha. Total nutrients input introduced by fertilization of crops was 15 483 kg N and 13 206 kg P (tab. 1).

Tab. 1 The quantity of nutrients input in Glavacioc catchments by fertilizers.

Crop type	Fertilized surface (ha)	Quantity of fertilizer (t/ha)	Quantity of TN (kg/ha)	Quantity of PT (kg/ha)	Total quantity of TN (kg)	Total quantity of TP (kg)
grain	31.29	0.275	20.62	35.75	645	1119
maize	104.3	10	50	4.9	5215	511
wheat	166	0.300	22.5	39	3735	6474
	41.6	15	75	7.35	3120	306
sunflower	123	0.300	22.5	39	2768	4797
Total input					15483	13206

Input of nutrient by untreated sewage In the Galvacioc basin there are 6 villages (Negrişoara, Glavacioc, Şelaru, Cătunu, Buteşti, Purani) and on small town (Ştefan cel Mare), situated along the river course. The population is supplied with water from the river Glavacioc and groundwater aquifers. N content in both sources is an average of 15 mg /l and the P is 2.5 mg /l. After use in the household contents in N and P increases reach values of 25 mg /l N and P 3.5 mg /l. Sewage created by the population of the river basin Glavacioc made an annual intake of 8577 kg N and 1299 kg P, the contribution of the population being 3169 kg N and 632 kg P (tab. 2).

Tab. 2 Quantity of nutrients input in Glavacioc catchmen by untreated sewage

Locality	No. of inh.	Water used/inh. (mean value)/ month (m^3)	Total input (kg/year) of nutrients and increase of nutrients added to water using			
			Kg/year N		Kg/year P	
Negrişoara	796	1.7	390	146	50	19
Glavacioc	814	2.1	533	226	69	31
Şelaru	2140	3.1	2229	1035	291	143
Cătunu	927	2.1	561	210	81	37
Buteşti	885	2	446	127	67	28
Purani	1685	2.8	1415	566	235	130
Ştefan cel Mare	3405	3.5	3003	858	508	243
Total	10652		8577	3169	1299	632

Comparing the two sources of input of nutrient intake, once can observe that most is made by the fertilization of crops. Nitrogen content in soil varies inversely with altitude; in agriculture land, where the altitude is high, the content is low and in wetland where the altitude is low the content is very high (fig. 5). The content is very similar in spring (April) and summer (July). The low content of nitrogen from agricultural land, pasture and forest with low slope is due to takeover by plants, here the oxygenation and humidity conditions of the soil not favor the removed of nitrogen by denitrification. In wetlands, where the denitrification conditions are favorable, the content of nitrogen is high. Although a small area of agricultural crops is fertilized and the amount of fertilizers used per area is relatively small, these fertilizers made a significant increase in soil nutrients. Intake of nutrients coming from fertilizers compared with intake of domestic water is 5 times higher in case of N and 20 from P. Therefore the policy of protection of surface water should be focusing on the sources of diffuse pollution from agriculture and not on the wastewater. Romania's strategy to reduce pollution of surface water is focusing on the requirements of European Water Framework Directive, and the diffuse sources in agriculture are not taken into account.

V. STRUCTURE OF VEGETATION AND PLANT DIVERSITY

Wetland (W) Species composition is represented by hygrophyte like: *Typha latifolia*, *Stachys palustris*, *Scirpus lacustris*, *S. sylvaticus*, *Lycopus europaeus*, *Phragmites australis*, *Lythrum salicaria*, *Ranunculus acris*, *Galium palustre*, *Epilobium hirsutum*, *Juncus glomeratus*, *Carex pseudocyperus*. The dominant species are: *Scirpus lacustris*, *Lythrum salicaria* and *Carex pseudocyperus*, and structure of the vegetation is simply represented by a single layer (herbaceous). The wetland vegetation is homogenous (the SD of the cover degree and high do not vary more than ± 5% and 7 cm), the species richness value is low (13 taxa). **Mixed forest (F_1)** In mixed forests, the species diversity, especially that of trees, is high (31 taxa: 10 trees species, 16 herbaceous species and 5 shrub species), but the bigger values of species richness is in querceta forest (37 taxa: 4 trees species, 26 herbaceous species and 7 shrubs species). *Trees layer* The mixed forest is a natural complex forest with different ages of the trees, with a great vitality, a complex structure (ten tree species) and an average productivity. It includes both types of species: the flooded area species like *Populus* and dry zone species like *Quercus cerris*. Individuals of the species *Acer campestre*, *Fracxinus excelsior F. ornus* have a unimodal distribution with high fervency, because are young trees with high spatial density, has not yet cut of individual of these species. Individuals of the species *Quercus cerris*, *Q. robur* and *Populus nigra* have a pluri-modal distribution with low fervency, because are old trees, these species have been exploited several times (fig. 4). *Herbaceous layer* The species richness is greater compared to the wetland (16 taxa) and the dominant species are *Erigeron canadensis* and *Glechoma hederacea*. The herbaceous layer has a large heterogeneity (cover degree and high of vegetation have high values of SD ± 65% and respectively 40 cm).

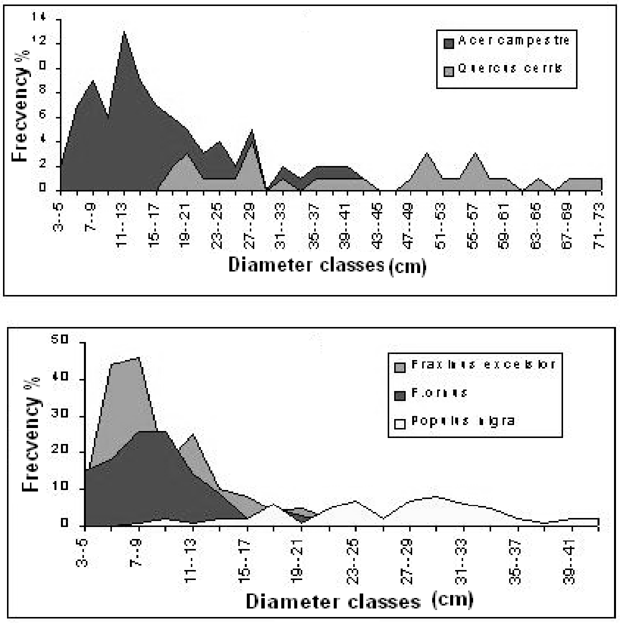

Fig. 4 The diameter distribution of age classes for *Acer campestre*, *Quercus cerris Fracxinus excelsior F. ornus* and *Populus nigra*

Querceta forest (F_2) *Trees layer* The querceta forest is a natural forest, with great vitality, medium complexity of structure (four trees species) and high productivity. Dominant tree species is *Quercus robur*, individuals diameters of trees are an equitable distribution (fig. 5). It includes only species specifically adapted for dry areas. *Herbaceous layer* The species richness is bigger compared to the mixed forest (26 taxa) and the dominant species are *Ficaria verna* and *Glechoma hederacea*. The herbaceous layer has a large heterogeneity (cover degree and height of vegetation have high values of SD ±70% and respectively 30 cm).

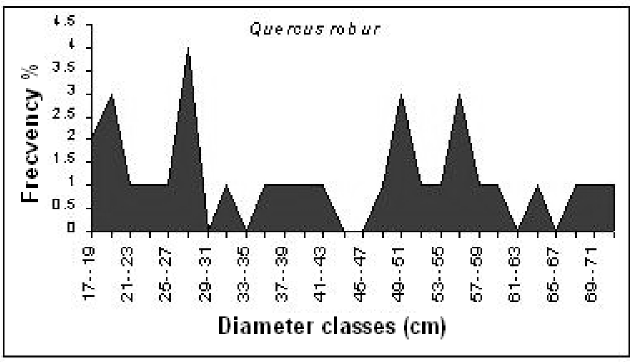

Fig. 5The diameter distribution of age classes for *Quercus robur*

Pasture (P) In the pasture, the species richness value is highest compared with other herbaceous layer present in the other four vegetation type (32 taxa), with the dominant species being *Elymus repens*. Except for the dominant species, individuals of other species are equitable distributed. The herbaceous layer has a low heterogeneity (cover degree and high of vegetation have following values of SD: ± 5 % and respectively 5 cm). **Agricultural land (A)** In agricultural land the species richness has the lowest value compared with other herbaceous layer present in other four vegetation types (7 taxa), the dominant species is *Triticum aestivum*. Except cultivated plants, ruderal plants are extremely underdeveloped. The herbaceous layer is very homogeneous (cover degree in all quadrates is 100% and SD of high of vegetation is 5 cm). In the pasture the number of species is very similarly with the mixed forest (32 taxa –only herbaceous species) the lowest specific diversity is recorded in agriculture land (7 taxa). In terms of specific composition in all type of vegetation the species present in common represents less than 20%. Although mixed forest (F_1) and querceta forest (F_2) belong to the same vegetation unit, specific composition is completely different. Vegetation on agricultural land (A) has a composition very low similar with the pasture (P). The species present in common in mixed forest and querceta forest represents almost 20%. The wetland (W) vegetation has no species in common with the other areas (A, F_1, F_2 and P) (fig. 6).

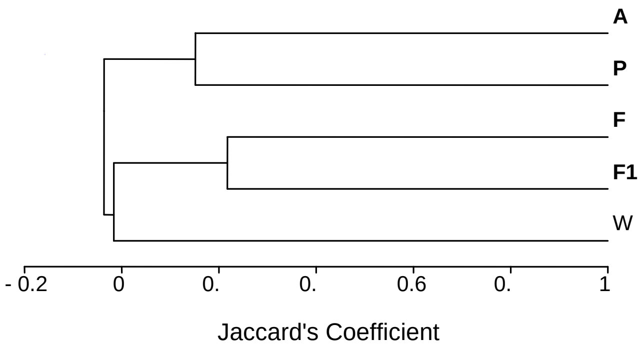

Fig. 6 Similarity between the species composition A, P, F_2, F_1 and W

BIOMASS; C, N STOCKC

Wetland (W) From the types of vegetation with one layer (herbaceous), the wetland is most productive vegetation type (tab. 3). The fraction between aboveground biomass and belowground biomass is subunit which indicates a low dryness tendency in the last 15-20 years. The C stocks represent approximately 49 % of the biomass and the N stock about 3.5 %. The carbon fixation rate, through photosynthesis, was much higher than that of nitrogen uptake by roots absorption (tab. 8). **Mixed forest (F_1)** *Trees layers* Most trees are old; the forest is mature with a large accumulation in the time of biomass and C, N stocks (tab. 4). Having a good state of vitality together with the absence of defoliation attacks and acid rain the leaf biomass is optimum for such forest (tab. 4). *Herbaceous layer* Due to competition for light, space and nutrients, the amount of biomass produced in herbaceous layer is the smallest compared to all herbaceous layers present in the other 4 vegetation types. The productivity in aboveground and belowground biomass is almost one third of the value of wetland productivity. The fraction between aboveground biomass and belowground biomass is subunit which indicates the same low dryness tendency like in wetland (tab. 3). The C stocks represent approximately 46 % of the biomass and the N stock about 2.2 %. The carbon fixation rate, through photosynthesis, was much higher than that of nitrogen uptake by roots absorption (tab. 4). **Querceta forest (F_2)** *Trees layer* The trees are young; the forest has a medium accumulation in the time of biomass and C, N stocks, but a high annual C and N uptake rate to compare with mixed forest. Having a good state of vitality, a young and growing foliar system, together with the absence of defoliation attacks and acid rain, the leaf biomass has higher values than in the mixed forest.

Herbaceous layer Because the competition for light, space and nutrients, is not so intense compared to the mixed forest, amount of biomass produced in herbaceous layer is comparable with amount of biomass in the pasture. The fraction between aboveground biomass and belowground biomass is subunit which indicates the same low dryness tendency like in wetland and mixed forest The productivity values in aboveground and belowground biomass are almost the same like in mixed forest (tab. 3). Although productivity levels are similar in the two types of forest, the accumulated biomass in querceta forest is greater because the shading period produced by trees leaf growing is shorter. The C stocks represent approximately 47 % of the biomass and the N stock about 2.2 %. The carbon fixation rate, through photosynthesis, was much higher than that of nitrogen uptake by roots absorption **Pasture (P)** The herbaceous total biomass value in pasture is similar with the biomass present in the herbaceous layer in the querceta forest (tab. 4). The fraction between aboveground biomass and belowground biomass is subunit which indicates a low dryness tendency in last period. The productivity values in aboveground and belowground biomass are almost the same like in the mixed and querceta forest (tab. 3). The C stocks represent approximately 48% of the biomass and the N stock about 2.7%. The carbon fixation rate, through photosynthesis, was much higher than that of nitrogen uptake by roots absorption (tab. 4). **Agriculture land (A).** The herbaceous biomass value in wheat crop is similar with value of biomass present in the pasture. The fraction between aboveground biomass and belowground biomass is > 1, is one area where drying trend is fought with irrigation. Wheat crop have recorded the highest values of primary productivity, this is the most productive area (tab. 3).

Tab. 3 Aboveground, belowground biomass, their rate, productivity, C and N content in herbaceous layers, July 2010

	Wetland	Mixed forest (F1)	Querceta Forest (F2)	Pasture	Agriculture land (A)
Dry biomass (g/m^2) Mean value ± SD					
Aboveground biomass	383 ± 26	42.85 ± 51	140.6 ± 35	202.4 ± 7.2	358.17 ± 22.9
Belowground biomass	1083 ± 38	114.57 ± 16	765.1 ± 43	539.6 ± 31.7	296.51 ± 13.1
Aboveground/ belowground ratio	0.354 ± 0.013	0.375 ± 0.011	0.184 ± 0.04	0.376 ± 0.024	1.208 ± 0.061
Productivity (g/m^2/day) Mean value					
Aboveground dry biomass	1.755	0.2445	0.400	0.737	4.241
Belowground dry biomass	4.735	0.5054	2.896	1.123	3.380
Carbon content (mg/g dry biomass) Mean value ± SD					
Aboveground dry biomass	498 ±28	485 ± 26	477 ± 28	483 ± 26	513 ± 28
Belowground dry biomass	486 ± 14	456 ± 38	468 ± 36	481 ± 18	499 ± 19
Nitrogen content (mg/g dry biomass) Mean value ± SD					
Aboveground dry biomass	22 ± 5	19 ± 6	19 ± 5	24 ± 11	19 ± 8
Belowground dry biomass	26 ± 8	23 ± 4	23 ± 8	28 ± 13	21 ± 4
Content of C and N in leafs of the trees					
Trees species in mixed forest (F1)	C content (mg C/g dry biomass)	N content (mg N/g dry biomass)	Trees species in querceta forest (F2)	C content (mg C/g dry biomass)	N content (mg N/g dry biomass)
Quercus cerris	497 ± 18	18 ± 4	*Quercus cerris*	497 ± 18	18 ± 4
Q. frainetto	501 ± 10	21 ± 7	*Q. frainetto*	501 ± 10	21 ± 7
Ulmus laevis	477 ± 14	23 ± 5	*Q. robur*	499 ± 22	23 ± 5
Q. robur	499 ± 22	22 ± 9	*Tilia cordata*	475 ± 17	16 ± 8
Fracxinus excelsior	464 ± 36	20 ± 3	*Quercus cerris*	497 ± 18	18 ± 4
Robinia pseudaccacia	468 ± 24	28 ± 11			
P. tremuloides x canadensis	476 ± 21	19 ± 7			
Acer campestre	473 ± 16	17 ± 9			
Populus nigra	480 ± 25	21 ± 4			
F. ornus	468 ± 18	14 ± 6			

The C stocks represent approximately 50.6 % of the biomass and the N stock about 1.99 %. The carbon fixation rate, through photosynthesis, was much higher than that of nitrogen uptake by roots absorption. The largest quantities of biomass are produced by mixed forests followed by querceta forests, a significant contribution it has a layer of trees. The least productive herbaceous layer is the grass present in mixed forest. The most efficient plant layer in C and N uptake is the wheat crop, but the stock is low because the plant stems and grains are removed (tab. 4).

Tab. 4 The biomasses, C, N stocks and C, N uptake in all five type of vegetation, in July 2010

Type of vegetation	No. of layers	Dry biomass (Kg/ha)	C stock (kg/ha)	N stock (kg/ha)	C uptake (kg/ha/year)	N uptake (kg/ha/year)
Wetland	Herb.	14660	7170	520	579.44	29.57
Mixed forest	Herb.	1560	723.5	34.2	637	2.97
	Stem	103150	51153	2294	1764	7.86
	Leafs	3724	1829.54	76.58	1829.54	7.66
	Total	108434	53706	2404.7	4230.54	18.49
Querceta forest	Herb.	9057	4251.3	202.7	282.17	13.54
	Stem	63160	31696	1239	2031.1	3.70
	Leafs	4359	2168.4	87.2	2168.4	8.72
	Total	76576	38115.7	1528.9	4481.6	25.96
Pasture	Herb.	7420	3573.1	199.7	163.54	8.97
Agriculture land	Herb. (wheat crop)	6546.8	3317	130.3	714.65	27.66

For wetland C and N stocks were similar in order of magnitude with the calculated by Ţopa in 2000 [14].

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

VI. CONCLUSIONS

The green infrastructure in Glavacioc basin is very heterogeneous. The following types of ecosystems here are: rivers and lakes, wetland with *Carex sp. Lythrum sp. Scyrpus sp.*, wetland with *Salix sp.* and *Typha sp.*, *Phragmites sp.*, pastures, 9 typologies of forest, 25 types of crops, villages and rural areas. This mosaic provides on one hand a high diversity, a source of natural resources (wood, biomass, food) and on the other hand great areas to reduce diffuse pollution from agriculture (riparian areas that function as buffer zones). Although 2010 was an atypical year in terms of rainfall distribution in time, ability of vegetation to reduce N diffuse pollution, fixed C and to produce biomass was remarkable. The number of species in the vegetal mosaic was 74; and number of ecosystems types was 41, of which the most numerous were the semi-natural and anthropogenic (27). The forested area in the Glavacioc basin occupies an area of 540 ha, and the annual mean wood production per ha is almost 6 m^3, here is producing almost 3240 m^3/year. The population in the basin represented by 10,652 inhabitants grouped in nearly 3200 households used in each year 16000 m^3 firewood, which means that 20% they get from local forests. The biomass production capacity of herbaceous layers at basin level is 15,656.552 t (1,319.4 t by wetland, 468 t by herbaceous plant in mixed forests 2,173.680 t by herbaceous plant in querceta forests, 241.892 by pasture and 11,453.580 t by straw and debris from agricultural crops), providing a daily diet for 521885 cows and annual food for 1430. About one in two households is able to secure food for an animal. In Romania the law prohibits grazing in forests (low 72/2002), thus 13.4% of biomass available cannot be used. The fixing capacity of C from carbon dioxide by photosynthesis at basin level is 4711.660 t (52.146 t by wetland, 1269.150 by mixed forest, 1073.384 t by querceta forest, 5.5330 t by pasture and 2309.450 t by crops), which is 0.000075‰ of total emissions of C estimated at global level (0.63 x 10^9 t), per year. The percentage seems insignificant but the vegetation covers a total area of only 3896 ha, with is 0.00043% the global land surface (9025 x 10^6 ha). Uptake N capacity of green infrastructure at basin level is 104,072.3 kg (2661.3 by wetlands, 5546.4 by mixed forests, 6230.4 by querceta forests, 292.4 by pastures and

89341.8 by agriculture land). The amounts of N coming from fertilizer at catchment's level is 15483 ka/year and from untreated sewage is 8577 kg/year and represent 23% of the uptake capacity of the vegetation in the basin, less than one quarter. Although in the 2008 report of Ministries of Environment and Forests it says that is an area with high potential for N pollution originating from agriculture, in 2010 was observed that the mosaic of vegetation used as a buffer zone was benefit at a rate of 23%. At present the Glavacioc basin in not a polluted zone with N from agricultural diffuse sources.

ACKNOWLEDGEMENTS

This work was supported by International Atomic Energy Agency - Soil and Water Management & Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, in the research program called Investigation of Nitrogen pathways in typical entropic-modified riparian zones of the Arges river catchment's area, Romania, Contract no. 15352. We thank Lee Heng and Sakadevan K. for assistance.

REFERENCES

1. Moreira, F.; Pinto, M. J.; Henriques, I. and Marques, T., 2005, 'The importantance of low-intensity farming Systems for fauna, flora and habitats protected under the European 'Birds' and 'Habitats' Directives: Is agriculture Essentials for preserving biodiversity in the Mediterranean region?' In: Burk, A.R. (ed.), Trends in Biodiversity Research. Nova Science Publishers, New York, pp. 117–145.
2. McCracken, D.; Klockenbring, C.; Zdanowicz, A. and Baldock, D., 2005. Agricultural biodiversity – issues to be aware of within MEACAP. Institute for European Environmental Policy (IEEP), Brussels.
3. Biala, K.; Terres, J.-M.; Pointereau, P. and Paracchini, M.L. (eds.), 2008. Low Input Farming Systems: an Opportunity to Develop Sustainable Agriculture. Proceedings of the JRC Summer University Ranco, 2-5 July 2007. JRC Scientific and Technical Reports. European Communities, Luxembourg.
4. Firbank, L. G., 2005. 'Striking a new balance between agricultural production and biodiversity.'Annals of Applied Biology 146(2): 163–175.
5. Le Roux, X.; Barbault, R.; Baudry, J.; Burel, F.; Doussan, I.; Garnier, E.; Herzog, F.; Lavorel, S.; Lifran, R.; Roger-Estrade, J.; Sarthou, J.P, and M. Trommetter (eds.), 2008. Agriculture and biodiversity. Benefiting from synergies. National Institute for Agricultural Research (INRA), Paris.
6. Cooper, T.; Hart, K. and Baldock, D., 2009. Provision of Public Goods through Agriculture in the European Union. Institute for European Environmental Policy, Brussels.
7. Gheorghe I.F. Fitocenologie şi Vegetaţia României, 2008. Ed. Didactică şi Pedagogică
8. McClaugherty C.A., Aber J.D., Melillo J.M., 1982. The role of fine root in the organic matter and nitrogen budgets of two forested ecosystems, Ecology 63: 1481-1490.
9. [9].Whittaker, R.H., 1978, The Braun-Blanquet approach. Classification of Plant Communities, Junk, The Hague.
10. Whittaker, R.H. and Marks, P.L., 1993, Methods of assessing terrestrial productivity in Leith, H. and Whittaker, R.H. (eds) Primary productivity of the Biosphere, Spinger Verlag, New York
11. Whittaker, R.H. and Woodwell, G.M., 1968, Dimension and production relations of trees and shrubs in the Brookhaven forest. New York, Ecol. 56: 1 - 25, Action plan for protection of waters against pollution caused by nitrates coming from agricultural sources", 2008, report of Ministries of Environment
12. Mitsch W.J., 1991, Estimating primary productivity of forested wetland communities in different hydrologic landscapes. Landscape ecology 5:75-92.
13. Mihaela Oprina Pavelescu "The critical mechanisms involved in the control soil flows of nutrients (nitrogen and phosphorus) in wide ecotonal areas", PhD thesis, 2007
14. Ţopa, S., Gheorghe, I. F., Vădineanu, A., 2000. Nutrient storage in riparian vegetation in the lower Danube floodplain. Internat. Assoc. Danube Res., 33, 143-148, Osijek. EEA, 2006. High nature value farmland. Characteristics, trends and policy challenges. EEA report No 1/2004. European Environment Agency, Copenhagen. EEA, 2009 a. Distribution and targeting of the CAP budget from a biodiversity perspective. EEA Technical report No 12/2009. European Environment Agency, Copenhagen. EC, 2003. CAP reform – a long-term perspective for sustainable agriculture. European Commission, Brussels. EC, 2008. Wildlife and Sustainable Farming Initiative. Species report – Outs scopes. European Commission, Brussels. EC, 2009 a. Provision of public goods through agriculture in the European Union. National Institute of Statistics "National Statistical Yearbook", 2007