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ON THE SUSCEPTIBILITY OF FOREST BIOMASS FOR BURNING AND COMBUSTION

Dan PASCARU[1], Cristina MODROGAN[2]

Despite the publication of a high number of articles, mainly edited compilations, on both fire ecology in general and, more specifically, fire ecology in the temperate zone; it remains difficult to obtain accessible overviews of many aspects of the subject. As a source of atmospheric carbon, biomass burning emissions associated with deforestation in the Romania are globally significant. These lands deforested and transformed in grasslands continue to be sources of substantial burning emissions for many years due to their burning.

The present work discusses the burning and combustion of the forest biomass, and the factors that concur to the appearance and increase of the phenomena. There are presented the combustion, burning and spreading conditions of the fire. We suggest some preventing measures of forest fires and diminishing factors of its spreading.

Keywords: biomass, burning, combustion

1. Introduction

The forest fire is a natural or anthropogenic phenomenon that can occur in any season, and it is very likely to have natural consequences by soil, air and water pollution. The factors contributing to the fire ignition and spreading are the subject of the present study [1].

It has been observed the relation between the natural environment and fire combustion and increasing of its power [2, 3].

High air concentrations of ammonium were detected at low and high altitude sites in Sweden, Finland and Norway during the spring 2006, simultaneous with air polluted from biomass burning in eastern Europe passing over central and northern Fennoscandia. Unusually high values for through fall deposition of ammonium were detected at one low altitude site and several high altitude sites in north Sweden. The occurrence of the high ammonium in through fall differed between the summer months 2006, most likely related to the timing of precipitation events. The ammonia dry deposition may have contribution to unusual visible injuries on the tree vegetation in northern Fennoscandia that

[1] PhD, Bioresources and Polymer Science Department, University POLITEHNICA of Bucharest, Romania, e-mail: pascarudan22@yahoo.com
[2] Lecturer, Department of Chemical Industry and Environment Engineering, University POLITEHNICA of Bucharest, Romania, e-mail: c_modrogan@yahoo.com

occurred during 2006, in combination with high ozone concentrations. It is concluded that long-range transport of ammonium from large-scale biomass burning may contribute substantially to the nitrogen load at northern latitudes. [4-7].

Conversion of mature tropical forests to agricultural landscapes releases carbon dioxide (CO_2) and other gases to the atmosphere that contribute to global warming through the greenhouse effect. One source of controversy in the evaluating the net effect of tropical deforestation is the extent to which carbon releases from the original clearing are attenuated by removal of carbon from the atmosphere through regrowth of secondary forests on the deforested sites [8-10]. The amount of carbon stored in the secondary forests and released at the time secondary forests are burned depends both on the biomass accumulation and completeness of the burns. Fixing the carbon in secondary forests is temporary, the age of the stands when re-cleared being important in determining the proportion of the total cycle (including use periods as agriculture or grassland) that is spent under secondary forest.

Charcoal formed in the burn, provides one of the only routes for carbon removal from the cycle, such that it cannot readily recombine with oxygen to form carbon dioxide. On the other hand, while burning the secondary forest biomass releases no more carbon dioxide than was removed from the atmosphere as the secondary forest grew this burning also releases methane (CH_4) and other trace gases that do not enter in photosynthetic reactions.

Burning of secondary forest biomass, therefore, has a net contribution to the atmospheric build-up of these non-CO_2 combustion products. Globally, burning of tropical secondary forests is estimated to release (under low and high trace-gas emissions scenarios), 3.1-3.7 × 10^6 mg CH_4, 73-92 × 10^6 mg CO, 0.2-1.6 × 10^6 mg N_2O and 2.4 × 10^6 mg NO_x [11]. Increased concentrations of trace gases, such as CO_2, CH_4, N_2O, and O_3, from biomass burning are potentially involved in the Earth warming effect by preferentially absorbing thermal infrared light in the troposphere and redirecting this energy back to the Earth [12]. Although the amount of CH_4 generated from burning is in the range 0.5–1.5% of CO_2, it has 25 times the radiative effect of CO_2 [13]. Important tropical sources of CH_4 include deforestation, cattle ranching, land-use-related burning (i.e., grassland, and fuel wood), termite activity and rice cultivation [10, 13]. CO emissions generated by smoldering combustion (i.e., combustion of coarse wood) are not radiatively active, but CO interacts with the hydroxyl radical and reduces the oxidizing capacity of $OH^\bullet$ to remove gases such as CH_4 from the troposphere [10]. CO_2, CO, and CH_4 represent the largest mass of carbon emissions from biomass burning however, hydrocarbon trace gases have more recently come to the attention of atmospheric chemists as to the detrimental role of these trace gases in atmospheric chemistry. Hydrocarbons make tropospheric O_3 when NO_x is present [14-17]. Also, hydrocarbons utilize OH•, decreasing OH• pools for removing detrimental tropospheric gases. Further, some hydrocarbons can be used as tracers for determining the source of burning emissions [18-23].

The present work discusses the burning and combustion of the forest biomass and the factors that concur to the appearance and increase of the phenomena. There are presented the combustion, burning and spreading conditions of the fire. We suggested some preventing measures of forest fires and diminishing factors of its spreading.

2. Measurement and technical devices

The research has been made according to the STAS and ISO specifications formulated for each determination.

The study area is located in the north-northeast area of Vîlcea county (Figure 1), Romania. This landscape is an enormous mosaic of ecosystems. Its components range from low-altitude grasslands (< 350 m) to arborous types at higher altitudes (> 2000 m). The samples were taken from different points and mixed to homogeneity. The samples were air dried, are ground and passed through a sieve of different grain size (0.7 to 0.2 mm). Samples are subjected to various analyzes.

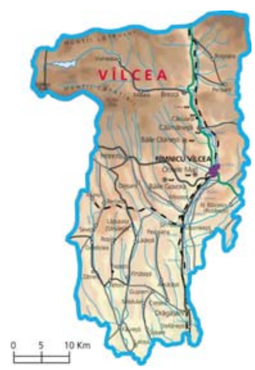

Fig. 1. The map of Vilcea county - the study area

The determination of humidity: The method consists in drying the determined sample under certain temperature conditions until they reach the constant mass value according with SR 8160/6-70.

The determination of ash: A sample of 2 g mass value and a maximum length of 0.2 mm from the forest biomass was weighted and mixed to homogenize. The weighed sample was introduced into a nacelle calcified until constant mass and leveled into a uniform layer by light pressing. The melting pot was weighted, subsequently being set into an oven at normal ambient temperature. The oven temperature was increased at 815°C, so that this value was reached within at least 60 minutes in order to avoid the sudden release of humidity and of volatile matters, which could engage, the fuel and ash particles according with SR 8160/9-97.

The caloric power has been determined by the complete burning into a calorimetric bomb, of a determined biomass quantity into a registered oxygen atmosphere temperature. The determination of volatile matters and constant coal: the determination consists in heating a biomass sample in the absence of air, at a determined time and temperature.

The mass loss of the biomass sample represents the sum of both humidity and volatile matters. The difference between the total mass lost and the one due to humidity, separately determined, it represents the content of volatile matters of the analyzed fuel (SR 5268/90).

Combustion Completeness

Combustion completeness (CC), also called combustion fraction, is highly variable between different fires under different conditions even in similar vegetation types. However, CC for different ecosystem types can be loosely associated with fuel: types, loads, configurations and resulting combustion processes associated with those ecosystems. In this study, ecosystem types with similar characteristics were grouped together and assigned a CC based on the literature survey. In some cases, we have used the averaged values for some of the ecosystem types because there are various field study results available for the same ecosystem type in the open literature, which give different numbers for CC. In the absence of a rigorous approach, we made an average of these values from the different studies to give a representative value of CC.

3. Results and discussions

There have been studied the majority of biomass samples existing into the forests, starting with the wood mass made of coniferous and broad-leaved trees, as well as the grass, the shrub and the moss.

It has been noticed that the analytical samples were made upon dry matters into the lab. The research has been extended upon samples containing 60% humidity.

The analysis of the samples aims to determine the humidity, ash content, volatile matters, carbon content and calorific power for the main types of forest biomass from area selected.

Table 1 shows the results obtained for these characteristics relative to air dry biomass and relative fuel mass.

Table 1

Analysis of main types of forest biomass from Vilcea county, Romania

Material		Humidity	Ash	Volatile Matters	Immovable Carbon	Superior Caloric Power
		W^i (%)	A^i (%)	V^i (%)	C^i_f (%)	Q^i_s (kcal/kg)
Determination Method		SR 8160/6-70	SR 8160/9-97	SR 5268/90		SR 8754/96
Moss	X^a	15.12	6.11	70.10	8.67	2807
	X^{mc}	60.00	2.87	33.04	4.09	1322
Herbs	X^a	14.01	5.74	69.80	10.45	2921
	X^{mc}	60.00	2.67	32.47	4.86	1405
Leaves	X^a	13.35	5.27	68.22	13.16	3011
	X^{mc}	60.00	2.43	31.49	6.08	1359
Shoots	X^a	12.24	5.15	65.24	17.35	3846
	X^{mc}	60.00	2.35	29.74	7.91	1759
Wood Leaves	X^a	12.02	0.86	71.69	15.43	3963
	X^{mc}	60.00	0.39	32.59	7.02	1802
Resin	X^a	13.15	0.41	72.04	14.40	3406
	X^{mc}	60.00	0.19	33.18	6.63	1536
Wood Soil	X^a	10.12	14.76	50.82	24.38	4769
	X^{mc}	60.00	6.57	22.60	10.83	2122

* X^a - the humidity, ash, volatile matters content, and superior caloric power value based on the air-dry test sample; X^{mc} - the humidity, ash, volatile matters, and superior caloric power value related to combustible mass; $C^i_f = 100 - W^i - A^i - V^i$

By analyzing the results presented in Table 1 the following conclusions can be drawn:

- Even at 60% humidity, the forest biomass can generate fires.
- The inorganic non-combustible mass contained by the forest biomass is very low fact which does not diminish or stops the combustion.
- The maximum water content taken into consideration namely 60% humidity, does not decrease the caloric power of the forest biomass with 360 kcal/kg, so that there is enough heat to allow the burning process.
- The content in volatile matters of the biomass, even if moist, it is increased, which determines easy combustion and fast burning of the biomass.
- The forest biomass has a power big enough to burn, even if it has a maximum state of humidity, as well as being dried into the lab.
- The forest soil is a part of the burning process.

In order to present the susceptibility of forest biomass for burning and combustion as eloquent as possible, we have shown in Table 2 the burning speed for the studied matters.

Table 2

The variation of burning criteria and of burning intensity depending on the type of forest biomass and its humidity

Material		K_a	The type of combustion	K_i	The burning intensity
Moss	X^a	8.08	fast	0.70	medium
	X^{mc}	8.08	„	0.70	„
Herbs	X^a	6.67	„	0.55	„
	X^{mc}	7.44	„	0.55	„
Leaves	X^a	5.18	„	0.40	low
	X^{mc}	5.18	„	0.40	„
Shoots	X^a	3.76	„	0.30	„
	X^{mc}	3.76	„	0.30	„
Wood Leaves	X^a	4.65	„	0.06	„
	X^{mc}	4.58	„	0.06	„
Resin	X^a	5.00	„	0.03	„
	X^{mc}	5.00	„	0.03	„
Wood Soil	X^a	2.08	„	0.60	medium
	X^{mc}	2.08	„	0.60	„

The determining of the burning speed, by thermogravimetric method it is not suitable because samples with low humidity will be analyzed in this type of studies. This can lead to error.

It has been used for this advanced method by N. Panoiu [2] and Ionescu Clement [3] as shown bellow.

$$K_a = V^i / C^i_f$$

where:

K_a = the combustion criteria

V^i = the percent from the volatile matters in the initial sample;

C^i_f = the Carbon fix percent from the initial sample

Depending on K_a values, the combustible materials can be classified as follows:

$K_a < 0.5$……low combustion capacity

$0.5 \leq K_a \leq 1$..medium combustion capacity

$K_a > 1$ high combustion capacity

$$K_i = A^i / C^i_f$$

where: K_i = the intensity burning criteria

A^i = the ash percent from the initial sample

Depending on the intensity of burning combustible materials can be divided into:

$K_i < 0.5$ the reduced burning intensity

$0.5 \leq K_i \leq 1$ the medium burning intensity

$K_i > 1$ the increased burning intensity

Table number 2 presents also the variation of K_a, K_i for forest biomass analyzed.

- The combustion criteria and the burning intensity do not depend on humidity but only on the structure of biomass.
- The existing forest biomass has increased combustion properties and low or medium intensity of burning.
- The moss, herbs and wood soil have medium burning intensity, and other types of biomass (leaves, shoots, woods leaves, and resin) have reduced burning intensity.

4. Conclusions

Results of this research study revealed that the danger of self combustion remains the same regardless the season, rain or humidity of the area. The forest burning intensity is low, excepting herbs and peat moss, which have medium burning intensity. The inorganic mass content of the forest is reduced, that is everything is involved in burning. The forest soil burns with high caloric power.

It is highly recommended protecting the forests of any possible combustion source, such as lightening, vehicles, human residences, railways, roads, electric lines. We must engage proper protection measures for every system mentioned. Residences must be placed at a distance from forests and insured against fire.

It is necessary to built dams and reservoirs near the forests, in order to have available water resources.

There has to be banned the access with fire sources into the woods.

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