RESEARCH ON CO_2 EMISSIONS FROM OLIGOTROPH PEATLAND IN APUSENI MOUNTAINS

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Abstract

Due to the major global changes that occur at such a rapid scale, urging us to adapt to new challenges, the present paper shares the universal interest in the CO_2 emissions, which, along with methane, protoxide of nitrogen, hydroflourocarbons, perfluorocarbons and sulfur hexaflourure, are responsible for the climate changes.Along with special concern for the protection and management of natural ecosystems in Europe, supported by the intense activities of identification and mapping high biodiversity centers, the study of histosols from Apuseni Mountains is also an acknowledgement that the uniqueness and the priceless value of these soils are tightly connected to the preservation of biodiversity and biological resources, as well as to its sustainable use and to the carbon loss reduction.

Key words: peatlands, CO_2 emissions, greenhouse gas, drainage, cropland, grassland.

INTRODUCTION

Peatlands are a major storage of carbon worldwide, accounting for 550 Gt carbon worldwide. The majority of carbon stored in peatlands is in the structured peat soil that has been sequestered over millennia. In the sub (polar) zone, peatlands contain on average 3.5 times more carbon per hectare than the above-ground ecosystems on mineral soil; in the boreal zone they contain 7 times more and in the humid tropics over 10 times more carbon (www.wetlands.org).

In Romania, eutrophic and oligotrophic peatlands share an area of over 6.000 hectares, more than half of these being found in Apuseni Mountains, sharing overall complex ecosystems, with unique biodiversity, accommodate glacial relicts (*Drosera intermedia, Boloria aquilonaris*).

Oligotrophic peatland is formed from accumulation of biological material, originating mainly from moss like *Sphagnum, Hypnum* and *Polytrichum* and also from specific oligotrophic plants and from plants that can grow on moss: *Empetrum nigrum, Eriophorum Vaginatum, Drosera Rotundifolia, Andromeda Polifolia, Vaccinium oxycoccus* etc.

Oligotrophic peatlands from Giurcuța de Jos, Bălcești and Bihor Mountains, in Apuseni Mountains, studied in this research, vary from 900 m in Călățele up to 1450 m in Bihor Mountains, the dominant vegetation

species being *Carex dioica, Calla palustris* and lowland community of *Rhynchosporion* on peat substrates.

Peat is defined as soil material that contains at least 30% (by dry mass) dead organic material (Joosten and Clarke, 2002). Others definition include a requirement that this material contains a limited material content, which is determined by measuring the ash left after burning (e.g. less than 55%; Wüst et. al., 2003).

Peat forms when inputs of dead plant organic matter to the soil exceed the mineralization and export of soil organic matter over a long period of time. These conditions generally require water levels to be near soil surface. Under these conditions, soil water saturation and oxygen deficiency limit the decomposition of soil organic matter, but still allow biomass production by locally adapted vegetation.

Although they occupy only 3% of the global surface, peatlands store 30% of terrestrial carbon. Present research studies emphasize contemporary concerns about global CO_2 emissions, which are in great part responsible for climate changes. According to FAO, about 26 million hectares of organic soils are utilized today for agriculture: 18 million hectares for cropland and 8 million hectares for pastures (figure 1).

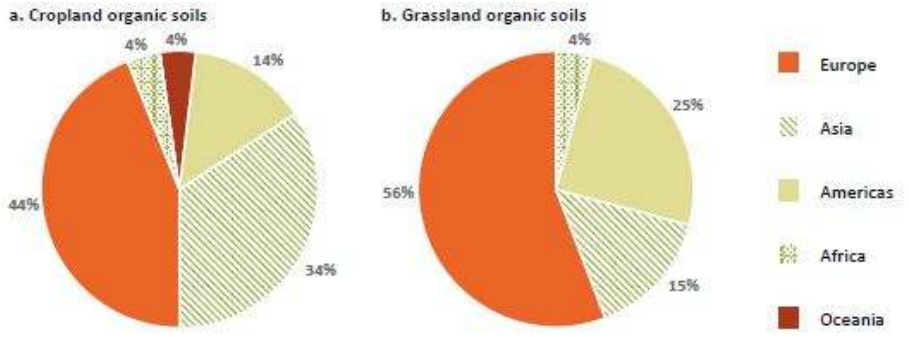

Fig. 1 Distribution of drained organic soils under a: cropland and b: grassland, by continent (FAO, 2014)

After year 2000, the rate of accumulation of carbon dioxide increased rapidly (Barnola et. al., 1995) (figure 2), tendancy noticed for methan, nitric oxide and other greenhouse gases.

Draining peatlands (figure 3) have as result at global emissions of CO_2 over 2.3 Gt (Joosten & Couwenberg, 2009), a figure that could be avoided by revitalizing and restoring peatlands (Trumper et. al., 2009).

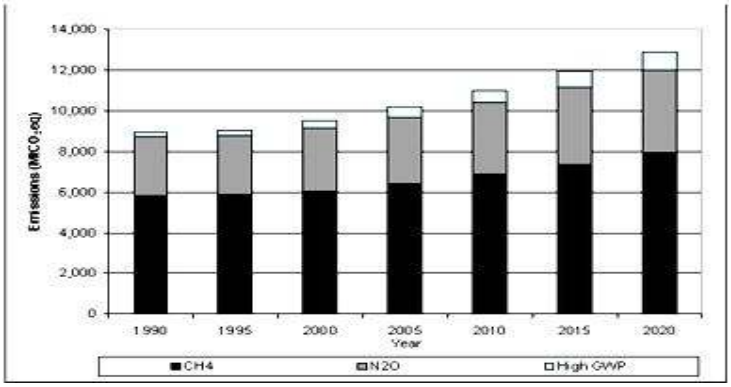

Fig. 2 The evolution of GHG in the atmosphere (Source: http://www.peatsociety.org)

Fig. 3 CO_2 emissions rate resulting from the global peatlands degradation (Source: http://www.wetlands.org)

MATERIAL AND METHOD

The research of the morphological description of soil was investigated by *Romanian System of Soil Taxonomy* (2012) and supplemented by *Development methodology soil studies*, elaborated by ICPA Bucharest in 1987.

CO_2 emissions from peat were recorded using a closed dynamic system developed by the company PP System (U.S.). The system consists of two major parts: the main module (CIRAS 2) on which is installed the operating system with an infrared sensor to determine the CO_2 quantity, the pump that provides the air flow and monitor to read the results; the second component of the system is the locked room with an area of 78.5 cm and a volume of 1171 ml. The two components are interconnected and the measurement procedure is controlled by the operating system installed in

the main module. Simultaneously with the CO_2 flow rate is determined the rate of evaporation from the surface of the soil.

In quantifying the CO_2 emission, gas analyzer was used, equipped with electrochemical sensors.

RESULTS AND DISSCUSIONS

The research area in this study are the oligotrophic peatlands from Giucuța de Jos, Bălcești and Bihor Mountains, areas identified in Apuseni Mountains.

Peat bogs from lower **Giurcuța de Jos** area are formed in open meadows and terraces of Someș Cald River on crystalline schists. Located at altitudes between 800 and 1000 m, peat bogs have much smaller areas, many of which were damaged by human activities. On Someș riverside, to the left, is located an oligotrophic peat bog, called „Tăul lui Onuț", spread over a surface of 0.2 hectares and the thickness of the peat does not exceed 1 m. The vegetation is typical for oligotrophic peat bog, with *Vaccinium myrtillus, Picea excelsa, Betula verucosa* and among them small spruces overlap. CO_2 emissions of peat bog Giurcuța de Jos area (figure 4) varies with depth, the highest values being recorded in the case of scaling soil. It is noted that peat bog from „Gura Firii", CO_2 emissions were about the same at the surface, even when it is uncovered. The explanation is that peat bog is heavily degraded due to overgrazing and deforestation that occurred in the area, vegetation cover is no longer compact, as a result the amount of emissions released are elevated, almost twice as high as the emissions from „Tăul lui Onuț" peat bog.

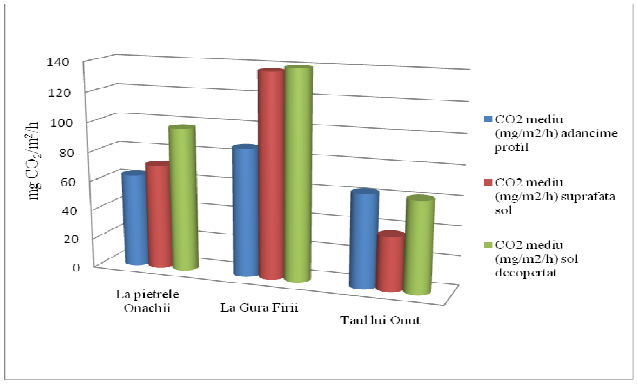

Fig. 4 CO_2 emissions variation in peatlands from Giurcuța de Jos area

The peat from Giurcuţa de Jos area has a very acid reaction (the pH value is approximately 4), its hydrolytic acidity is very high (75,10-91,01 me/100 g soil), and the organic matter content is also high (83,28-93,17%). The carbon content varies between 51,68 and 54,04% slightly below of quality peat average (58% carbon), while N content is rather low (no more than 1,010%).The ash amount of peat is of 9,54%; the peat has a low quantity of minerals, P_2O_5 (less than 0,0703%), and K_2O (below 0,062%).

Swamps belonging to the group **Bălceşti** (Beliș) are found in mountainous plateau, that lies between the village Bălceşti and Călăţele, at 900-1200m an altitude. CO_2 emission from soil surface varies in the range of 59.73-82.15 mg $CO_2/m^2/h$, with an average of 16.34 mg $CO_2/m^2/h$ lower than the CO_2 stripped from the stripped soil surface, the amount of emissions being influenced by tread depth (figure 5).

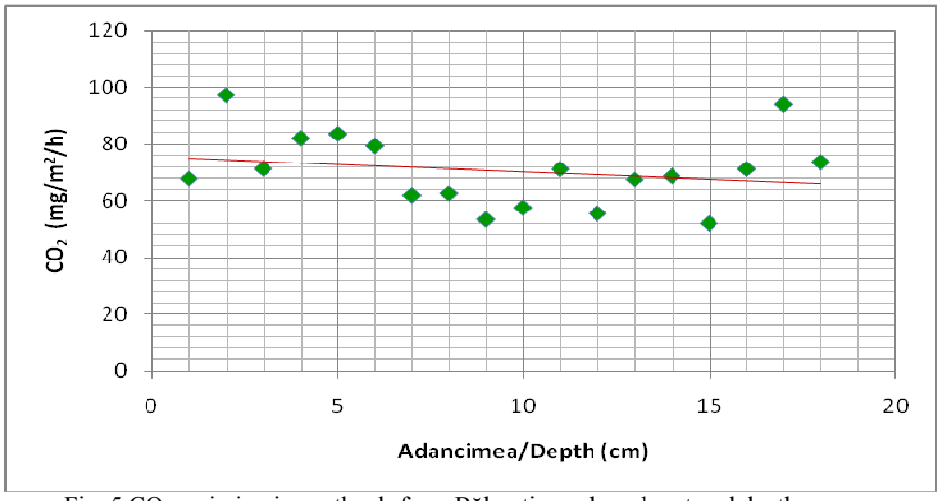

Fig. 5 CO_2 emission in peatlands from Bălceşti area based on tread depth

The peat from Bălceşti area has a very acid reaction, the mean value of its pH being 4.11, the hydrolytic acidity is very high (85,1-110,34 me/100 g soil), as well as the content of organic matter (84,12-98,92%). Although the maximum nitrogen content is of 1.307%, it falls within the limit values of oligotrophic peat from our county (Obrejanu et. al., 1958). The carbon content varies between 48.79 and 56.9%.

Although currently peat bog from **Bihor Mountains** is largely covered with vegetation, being in a process of rehabilitation, the average of CO_2 emission is 115.14 mg/m^2/h. The amount of peat stored by peatlands from Bihor Mountains is negligible, the vegetation consists of eutrophic sfagnete or pass with wet carex and emissions to values of up to 256 mg CO2 / m2 / h (table 1).

Table 1.

CO_2 emissions within Bihor Mountain peatlands

Peatland	Moisture (%)	Temperature ^0C	CO_2 ($mg/m^2/h$)
Molhaşul cel Mare de la Bârsa	54	28	218
Mlaştinile de la Calciş	48	32	256
Mlaştinile de la Sâvla	63	27	183
Turbăria Cuciulata	57	28	223
Turbăria Cârligaţi	49	24	143
Mlaştinile de la Onceasa	56	23	179

The amount of CO_2 emitted was recorded using gas analyzer SafeLog100, emissions being directly influenced by humidity and temperature (figure 6).

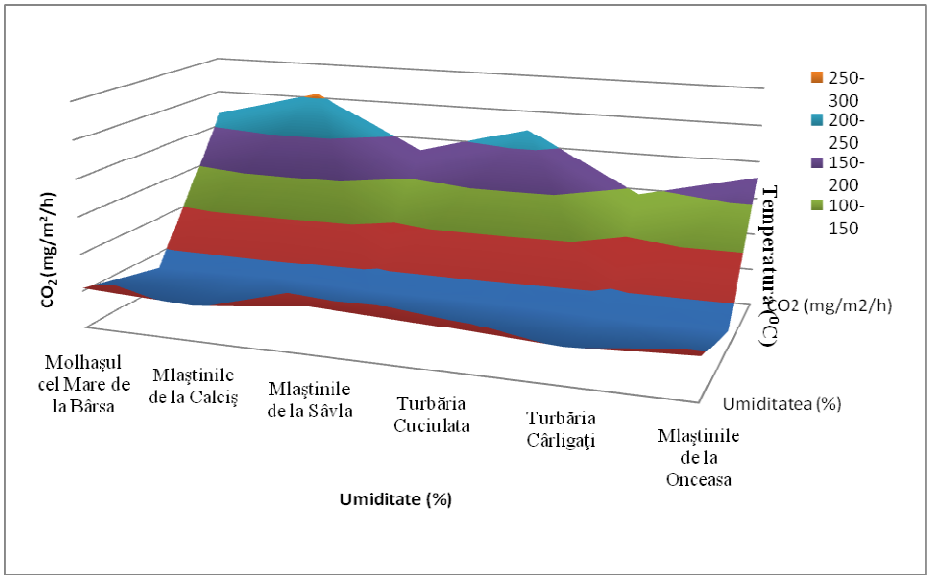

Fig. 6 CO_2 emissions variation based on temperature and moisture content

The Bihor Mountais peat is slightly acid, almost neutral, entering eu-mesotrophic soils category; the average value of its pH is 5.11. The total amount of nitrogen has values that range between 0.87% and 2.78 % and its average value is 1.62%. The carbon content values (figure 5) vary from 36.64% to 55.66 % and the C:N ratio has low values (13.01 – 66.30) as a result of the peat's advanced mineralization (decomposition).

The high content of ash, 15.12% on average, prove the peat's rich content of minerals, for the values of P2O5 and K2O range from 0.0413% to 0.27% and from0.0197% to 1.04 %, respectively.

CONCLUSIONS

The present study focused on the histosols in Apuseni Mountains, their physical and chemical properties, on biodiversity inventory and the quantification of the amount of carbon stored in peatlands, lead to the following conclusions.

Peatlands are a priceless component of the environment; their positive effects on the environment are reflected in the diversity of plants and animals communities and hydrologic fluctuations, which are important for the entire society. Due to their orographic and geologic structure and the hydrologic regime, rich in precipitations and propitious for the existence of *Sphagnum* species, out of the 265 high peat bogs (oligotrophic) within Romania, 99 are located in the Apuseni Mountains.

The peat of Giurcuţa de Jos area is very acid (the pH value is approximately 4), its hydrolytic acidity and the content of organic matter are very high. The carbon content varies between 51, 68 % and 54, 04%. The peat bog of Bălceşti area is typical; the peat has a very acid reaction, the average value of its pH is 4.11, the hydrolytic acidity is very high (85.1 – 110.34 me/100 g sol) as well as the content of organic matter. The carbon content varies between 48.79 and 56.9%. The excessive exploitation of peat from Bălcești leaded to the sudden and permanent elimination of the entire ecosystem. Despite of the fact that today the peat bog is largely covered with vegetation and is recovering, the average of CO_2 emissions is 115.14 mg $CO_2/m^2/h$.

The peat of Bihor Mountais has a slightly acid pH, almost neutral, falling into the category of eu-mesotrophic soils.

Comparing the average of CO_2 emissions of European peatlands with that recorded in the Apuseni Mountains, we can notice that there are not significant differences. CO_2 emissions in soil in a depth of 40-60 cm have a lower influence on CO_2 emission from the surface of peatlands.

REFERENCES

1. Barnola, J.-M., M. Anklin, J. Porchcron, D. Raynaud, J. Schwander, J. Stauffer, B. 1995, CO_2 evolution during the last millennium as recorded by Antarctic and Greenland ice, Tellus, 47f3, 264-272.
2. Joosten H, Couwenberg J., 2009, Are emission reductions from peatlands MRV-able? Wetlands International, Ede, 14 p
3. Joosten, H., Clarke, D., 2002, Wise Use of Mires and Peatlands. Background and Principles Including a Framework for Decision-Making. International Mire Conservation Group and International Peat Society.
4. Obrejanu, Gh., Stînga, N., Blănaru, V.,1958, Carcterizarea agrochimică a unor zăcăminte de turbă din R.P.R, Buletinul Ştiinţe şi Ştiinţe Agricole, Secţiunea Biologie, al Academiei R.P.R, VIII, nr.4.
5. Trumper, K., Bertzky, M., Dickson, B., van der Heijden, G., Jenkins, M., Manning, P. June 2009, The Natural Fix? The role of ecosystems in climate mitigation. A UNEP rapid response assessment. United Nations Environment Programme, UNEPWCMC, Cambridge, UK, ISBN: 978-82-7701-057-1.
6. *** Romanian System of Soil Taxonomy, 2012
7. ***FAO, 2014, Agriculture, forestry and other land use emissions by sources and removals by sinks -1990 – 2011 Analysis, by F.N. Tubiello, M. Salvatore, R.D. Cóndor Golec, A. Ferrara, S. Rossi, R.Biancalani, S. Federici, H. Jacobs, A. Flammini. *ESS Working Paper 2*, Rome, 87 pp.
8. ***The methodology for development of soil studies, ICPA Bucharest, 1987
9. ***www.peatsociety.org
10. ***www.wetlands.org