ENVIRONMENT IMPACT ON CROP-SCALE RESPIRATION

Ligita Balezentiene, Arnoldas Uzupis
Aleksandras Stulginskis University, Lithuania
ligita.balezentiene@asu.lt, arnoldas.uzupis@asu.lt

Abstract. Croplands cover approximately 45 % of Europe and play an important role in the overall carbon budget of the continent. However, the estimation of their carbon balance remains uncertain due to the diversity of environment and climatic indices, crops together with the strong influence of human management. Based on the continuous observation of soil-plant respiration and environmental factors in a several crops ecosystem from early June to early July in 2010, the spatial and temporal variation of soil-plant respiration and their controlling factors were analyzed. A survey was conducted to identify important criteria, and several crop fields were introduced which represent different value systems by varying criteria importance. The approach is based on the local measurement and comparing the impact of environment physical indices on agro ecosystem productivity at crop habitat scale. The study was conducted in intensive grassland, barely, winter wheat and maize ecosystems at a conventional farm (Kalvarija distr., 54°28′ N, 23°38′ E). The data have been collected in a real time using digital sensors of the humidity, pressure, gas concentration, solar intensity, wind speed and temperature. All the dependencies of the various physical data were valuated according to the plant growth. The data were obtained in productive grasslands with different fertilizer application and in crop fields of different geographical location. The experimental data confirm that the average meteorological data obtained from the State Meteorology Stations are quite preliminary and cannot be unambiguously considered as the environmental factors on the wide area of vegetation with different soils. The picked data set should be used when analysing ecological drivers on the fluctuation of the climate. Measurement of the properties that affect fluid storage and transport, such as macro porosity, provided soil quality indices that helped in recommending suitable soil management systems.

Keywords: physical indices, respiration, ecosystem, spatial variation.

Introduction

Human-inflicted greenhouse gas emissions affect the global temperature [1]. The United Nations have summarized greenhouse gas (GHG) annual increase of 0.4 (CO_2); 0.6 (N_2O) and 0.25 % (CH_4). Therefore, it is actual to reduce this main agent of climate change, i.e., GHG emissions in the agricultural sector as well as in others activities. Grasslands (3488 M ha, or 69 %) occupy a large segment of global agricultural land (5023 M ha), consequently, measurement and prediction of GHG emissions from these ecosystems are of great importance [2]. Furthermore, the amount and composition of the covering plant species impact considerably the total GHG emission in grassland ecosystems [3]. In Central Lithuania, like in other parts of central Europe, abandoned grasslands situated near woodlands are overgrown by shrubs and trees [4].

However, rising fertilizer use contributed to a number of environmental problems including an increase of GHG emissions [5-6]. Moreover, intensive recycling and often high rates of the applied mineral fertilizers are expected to be a significant pathway for contribution to share of global anthropogenic GHG emission share from the agro sector [1; 7].

This paper reports preliminary results from a project designed to investigate the field scale interactions between the productivity of plant-soil biota ecosystem and environment physical indices (ambient and soil temperature, soil compactness, humidity, greenhouse gas (GHG) emission, etc.). The approach is based on the local measurement and comparing the impact of environment physical indices on agro ecosystem productivity at crop habitat scale.

Materials and Methods

Biosphere-atmosphere interactions were investigated on a light deeply carbonate washed light loam soil (Bathihypogleyi–Calc(ar)ic Luvisol) [8] in semi natural and intensive grassland ecosystems. Physical measurements of abtiotic parameters were run in June, when the meteorological conditions were optimal for intensive plant and soil biota physiological processes, in absence of frost stress. The experimental site was situated 250 m of the nearest buildings. The vegetation at the site semi natural grassland (dominated Poaceae), developed on a neutral soil which has been cultivated in the past. The plant height was ca. 15-20 cm. Fresh mass (FM) weighting and drying (105 ºC) were used to obtain dry mass (DM, %) and grassland productivity ($g \cdot m^{-2}$). The harvest data were obtained from eight sites

(1-8) and from intensive grassland (IG). The gas samples were analyzed in the laboratory by the infrared gas analyzer (MGA3000) calibrated separately for each gas using the ML-800 gas standartd (2 atm).

The Campbell and Pasco instruments were used to measure the physical parameters of the environment conditions. Physical parameters of environment have been arranged using sensors: radiometer CNR2, humidity sensor PS 2174, compaction meter SC 900, and Campbel temperature probe CM 107. The results were collected twice, evaluating the change of the solar radiation, temperature etc. every 7 days during the vegetation period.

The results were evaluated statistically by using package Statistica (StatSoft) programme ANOVA. The confidence limits of the data were based on the Student's theoretical criterion at the level of statistical significance $p < 0.05$. In order to reveal major vegetation and environment gradients, multiple correspondence analysis (MCA) was used to analyze the data statistically, using the statistical package STATISTICA of StatSoft [9]. The main aim of this method is the analytical description of the data that correspond to qualitative variables without a priori constraints and limitations. This method also allows the discovery of new complex variables that characterise the data as a whole. The MCA requires categorical data rather than quantitative, thus the initial data were classified into three groups. The initial data were therefore transformed by calculating mean ($\bar{x}_i$) as well as standard deviation (s_i) for each i-th variable and then assigning group 1 the lowest values of the variable (i. e. $x_{ij} \leq \bar{x}_i - 0.5s_i$); group 2 with them medium values ($\bar{x}_i - 0.5s_i < x_{ij} \leq \bar{x}_i + 0.5s_i$); and group 3 with the highest values ($\bar{x}_i + 0.5s_i < x_{ij}$) respectively, with j being the number of variants.

Results and Discussion

Micro gas emissions from agricultural production compose global drivers of climate change [10], therefore, analyzing physical parameters of grassland environment and emissions of biogenic micro gas, influenced by the changes of moisture, the solar radiation intensity, temperature, wind speed and absolute pressure investigations were arranged (Fig. 1-4).

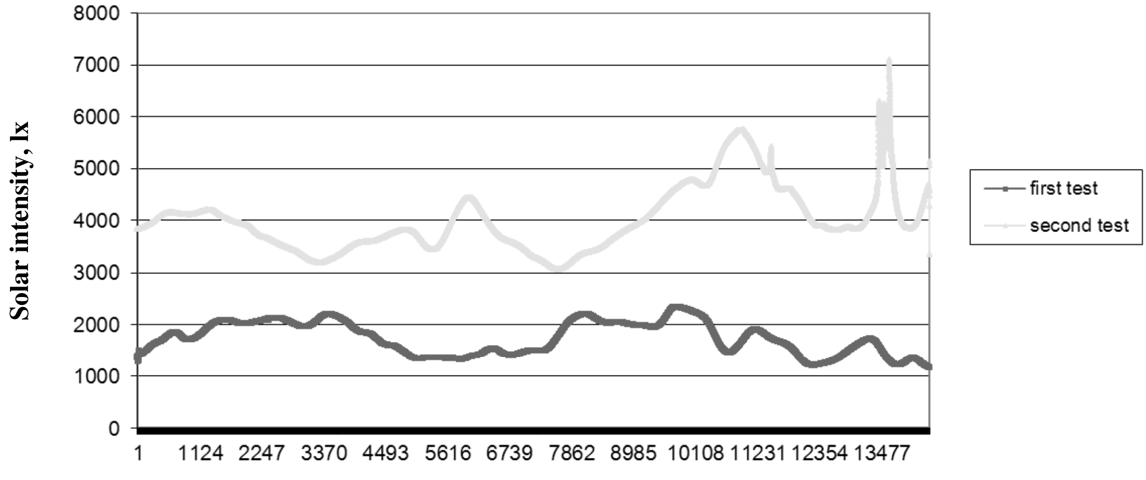

Fig. 1. **Solar radiation data**

As we see, the ambient temperature directly depends on the weather speed and solar intensity (Fig. 1). Solar radiation was observed different during the experiment time. Radiation was higher (3900-7100 lx) during the second experiment measurement due to less cloudy conditions.

The medium ambient temperature was 23-27 ºC – first measurement and 28-23 ºC – second measurement (Fig. 2). The average soil temperature was 17.5 ºC, during the experiments. The wind speed approximately was changing for 0.1-0.3 $m \cdot s^{-1}$ (Fig. 3).

Weather humidity is a very important climatic condition for the growth of plants and biogenic micro gas formation also. Weather humidity (Fig. 4) is changing depending on the weather conditions, namely, sunny/cloudy day, solar radiation and weather temperature. During the second measurement relative humidity was observed lower (50-37 %) due to higher solar radiation and weather temperature.

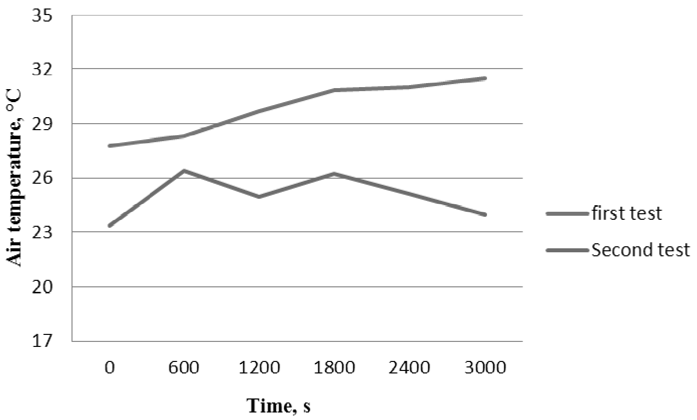

Fig. 2. **Daily air temperature**

Anthropogenic land use and land cover change can also modify climate through other mechanisms, some directly perturbing the Earth radiation budget and some perturbing other processes. Impacts of land cover change on emissions of CO_2, N_2O and CH_4 in different grassland sites (Fig. 5). MCA confirms ca. 55 % variation between the investigated variables. The lowest CH_4 and N_2O emissions and DM correlated with site 1-3. The highest fluxes of CO_2 and N_2O related with low legumes (L1), thus high grasses (G3) composition and dry mass harvest (DM3) in sites 4, 5 and 7. The highest emission (CH_4 3) of long lived gas CH_4 obtained in intensive grassland is possibly due to higher soil density and soil moisture content there. The trend of CH_4 relation with anaerobic environment corresponds with multiple references [11; 12].

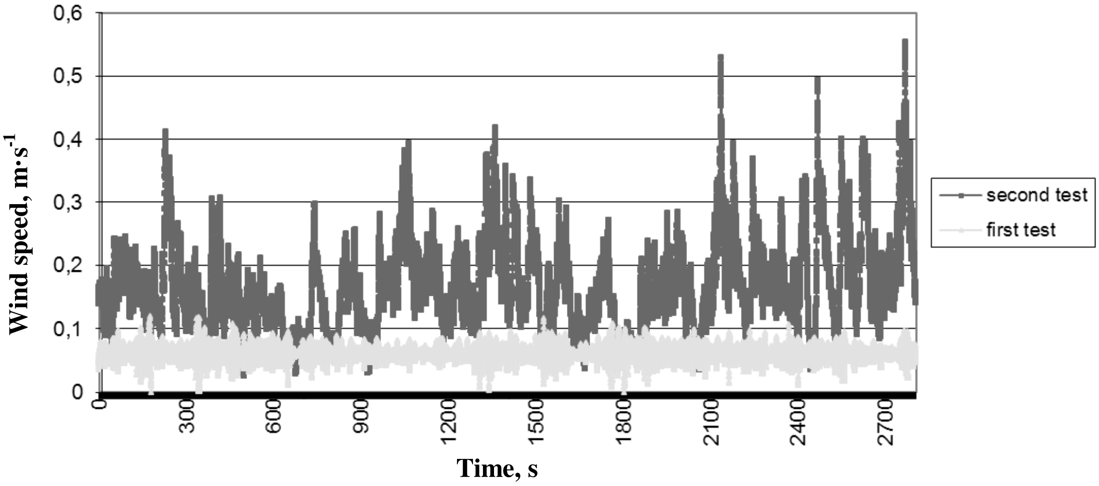

Fig. 3. **Wind Speed**

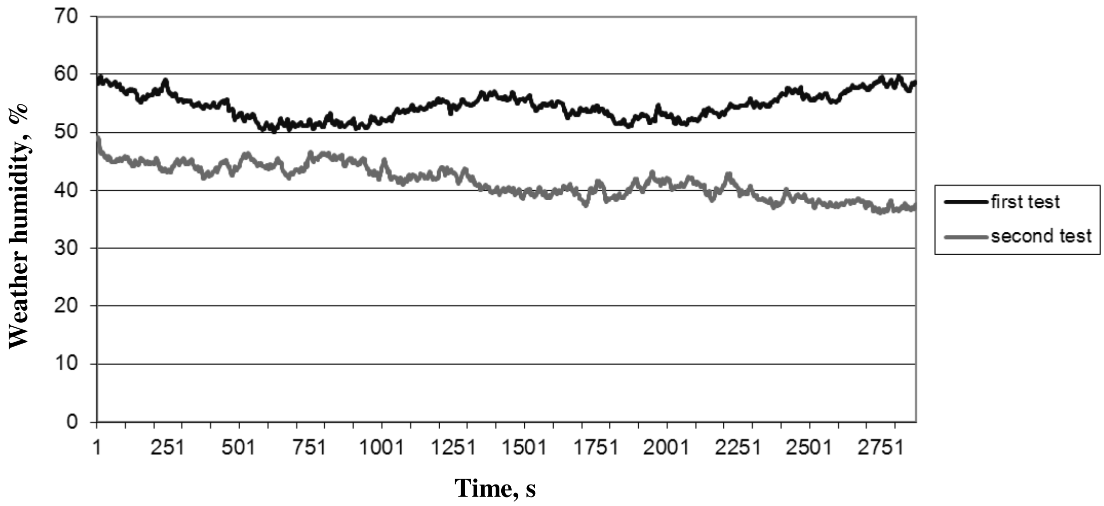

Fig. 4. **Weather humidity**

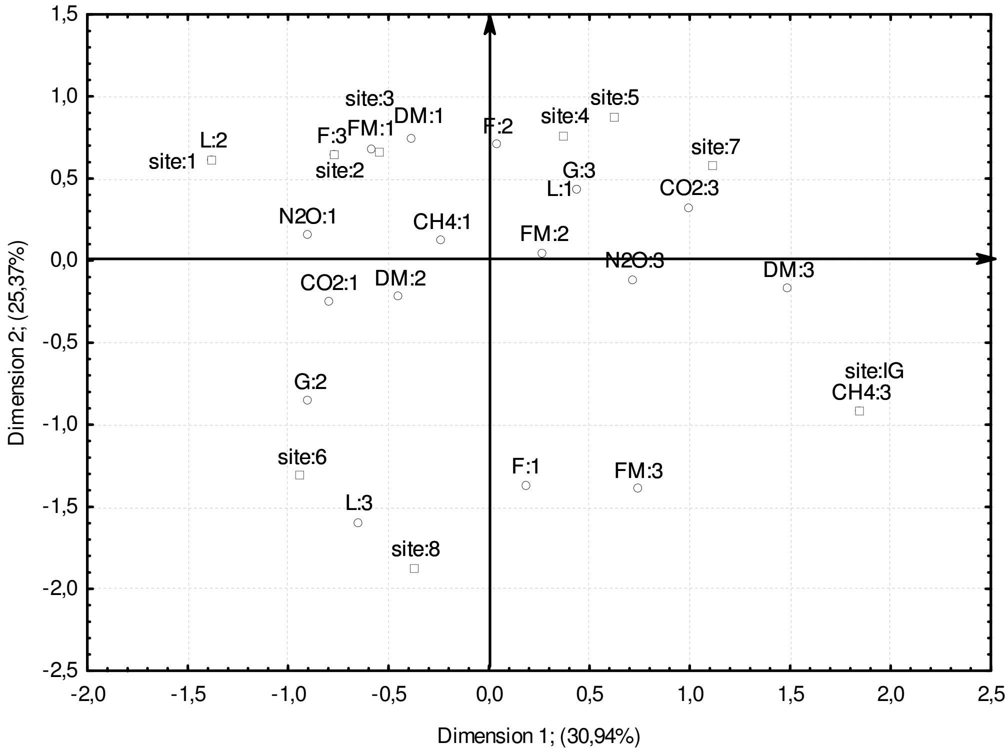

Fig. 5. **Relationships (ca. 55 %) between micro gas emissions, grassland bioproductivity (FM, DM), and plant (G – grass, F – forbs , and L – legumes) in tested sites**

Conclusions

The plant cover and productivity varied depending on the sites and climate parameters. Grassland site and abiotic environment parameters have changed emissions of long-living micro gas CO_2, NO_2 and CH_4. As an anthropogenic or natural emission can affect several forcing agents, it is useful to assess the current radiative forcing caused by each primary emission.

Progressing of better understanding relationships between the plant and environmental parameters will serve as an excellent tool for estimating emission factors for individual change in land management or combinations of management changes.

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