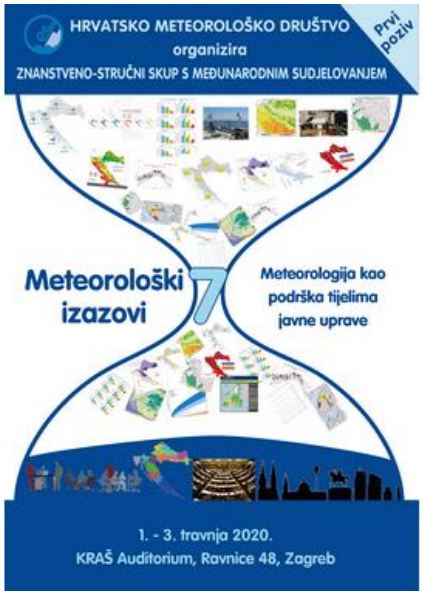


# SOIL RESPIRATION IN AGROECOSYSTEMS

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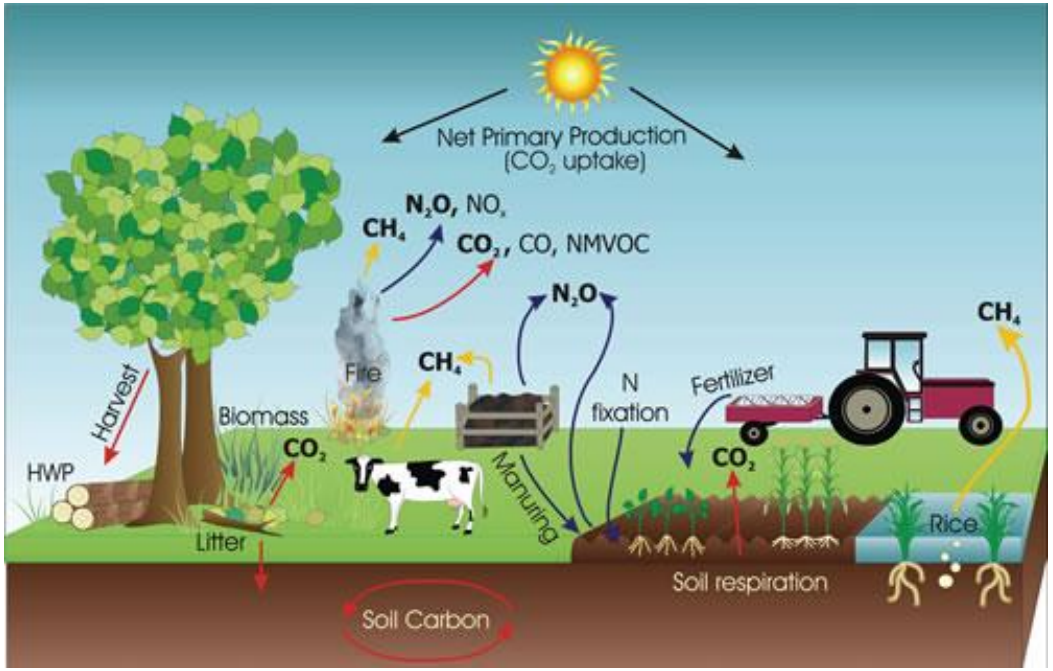
# Introduction

- it is presumed that increased concentrations of GHG emissions cause the global warming which is obvious in all parts of the world as well as in the RC

- among GHG, carbon dioxide ($CO_2$) is the primary greenhouse gas emitted through human activities




*Sources and sinks of GHG emissions in agriculture, forests, and other land use systems (IPCC 2006)*

- one of the sources of $CO_2$ emissions in agriculture, forests and other land use systems is soil respiration

# Aim of the research

- As soil respiration vary significantly among major plant biomes and climate conditions the aim of the study was to determine how soil respiration is influenced:
  - by growth of energy (*Miscanthus x giganteus)* and arable (winter wheat, maize) crops
  - by meteorological parameters (air temperature and relative air humidity).

# Materials and methods - experimental sites

Experimental site 1: Bistra – continental part of Croatia (N 45°55‘06.2", E 15°50‘32.5“, 144 m a.s.l.)


Izvor: Google Earth

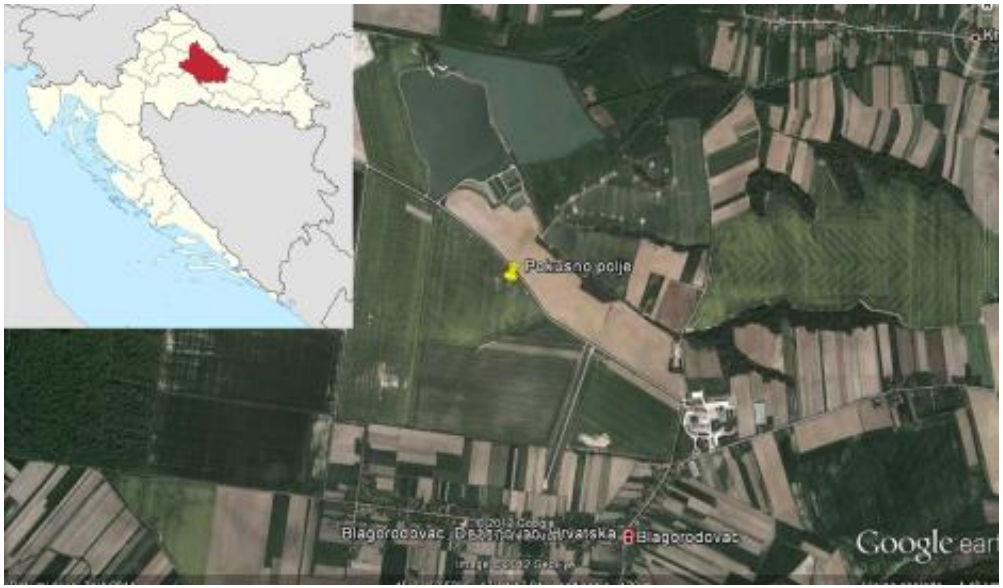
- continental humid climate (1961-1990):
  - mean annual temperature: 10.2 °C,
  - mean annual precipitation: 1054 mm
  - mean annual evapotranspiration: 660 mm
- soil:
  - 21% of sand
  - 66% of silt
  - 13% of clay
- Giant miscanthus *(Miscanthus x giganteus Greef et Deu)* :
  - ploughing30 cm and herbicide application: only in the establishment year
  - fertilization (N60): spring 2013
  - harvest: autumn 2013

Experimental field was established in 2011:

1. “Uvođenje trave Miscanthus kao energetske kulture za grijanje plastenika na OPG-u” - leader: Full Professor Tajana Krička, PhD

# Materials and methods - experimental sites

Experimental site 2: Blagorodovac – continental part of Croatia (N 45°33'54.2", E 17°01'45.07", 133 m a.s.l.)




Izvor: Google Earth

- continental humid climate (1961-1990):
  - mean annual temperature: 10.6 °C,
  - mean annual precipitation: 878 mm,
  - mean annual evapotranspiration: 671 mm
- Soil:
  - 2% of coarse sand,
  - 59% of fine sand,
  - 24% of silt
  - 15% of clay.
- Winter wheat (*Triticum aestivum L.*):
  - sowing: October 2012
  - harvest: July 2013
  - tillage (ploughing$_{30\ cm}$), fertilization ($N_{150}$), weed and pest control were done according to the good agricultural practices.

Experimental field was established in 1994:

1. "Konzervacijsko gospodarenje tlima izloženim djelovanju erozije vodom" - leader: Full Professor Ivica Kisić, PhD

2. „Utjecaj različitih načina korištenja tla na klimatske promjene" - leader: Assistant Professor Željka Zgorelec, PhD

# Materials and methods - experimental sites

Experimental site 3: Potok – continental part of Croatia (N 45°33‘21.42", E 16°31'44.62", 93 m a.s.l.)


Izvor: Google Earth

- continental humid climate (1961-1990):
  - mean annual temperature: 10.6 °C,
  - mean annual precipitation: 865 mm
  - mean annual evapotranspiration: 655 mm
- soil:
  - 1% of coarse sand
  - 55% of fine sand
  - 30% of silt
  - 14% of clay
- Maize (*Zea mays L.*) :
  - sowing: May 2013
  - harvest: October 2013
  - tillage (ploughing$_{30\ cm}$), fertilization ($N_{150}$), weed and pest control were done according to the good agricultural practices.

Experimental field was established in 1996:

1. “Gnojidba dušikom prihvatljiva za okoliš” - leader: Full Professor Milan Mesić, PhD

2. „Gospodarenje tlom i klimatske promjene” - leader: Assistant Professor Željka Zgorelec, PhD

# Materials and methods - measurement of $CO_2$ concentrations

- soil $CO_2$ concentrations (ppm):
  - closed static chamber method (chamber construction: FAUZ & Tukač company)
  - detector of carbon dioxide GasAlertMicro5 IR
  - once per month from April till October 2013. (n = 63)

# Materials and methods
## - calculation of $CO_2$ efflux

$CO_2$ efflux was afterwards calculated according to Widen and Lindroth (2003) and Toth et al. (2005) as:

$$F_{CO2} = [M * P * V * (c_2 - c_1)] / [R * T * A * (t_2 - t_1)]$$

$F_{CO2}$ – soil $CO_2$ flux (kg/ha/day)
M – molar mass of the $CO_2$ (kg $mol^{-1}$)
P – air pressure (Pa)
V – chamber volume ($m^3$)
$c_1$ – initial concentration of $CO_2$ (µmol $mol^{-1}$)
$c_2$ – concentration of $CO_2$ after incubation time (µmol $mol^{-1}$)
R - gass constant (J $mol^{-1}$ $K^{-1}$)
T – air temperature (K)
A – chamber surface ($m^2$)
$t_2 - t_1$ – incubation period (day)

# Materials and methods
## - measurement of met. parameters

- Testo 610 (2011)
  - air temperature (°C)
  - relative air humidity (%)
  - height ~ 1 m above the soil surface.

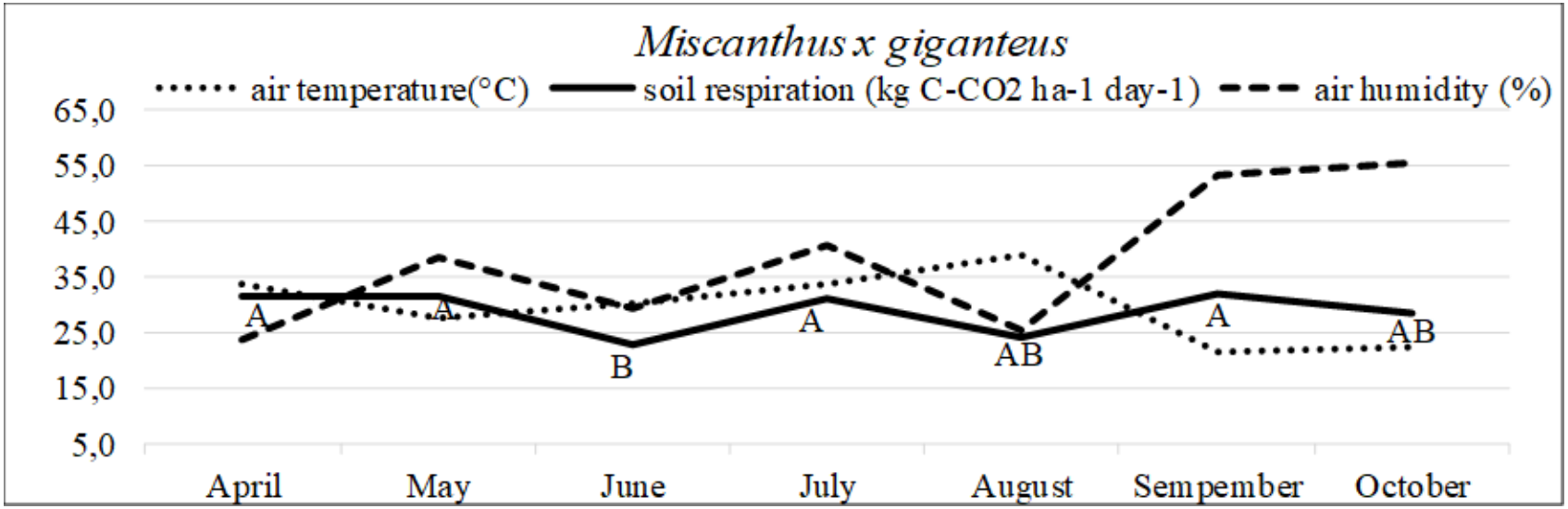
# Results
## - temporal variation

Bistra - Miscanthus x gigantheus:

- soil respiration:
  - 22.7-32.1 kg C-$CO_2$ $ha^{-1}day^{-1}$
  - spring>autumn>summer (31.5>30.3>26.0 kg $ha^{-1}day^{-1}$)

- air temperature:
  - 21.7-39.0°C

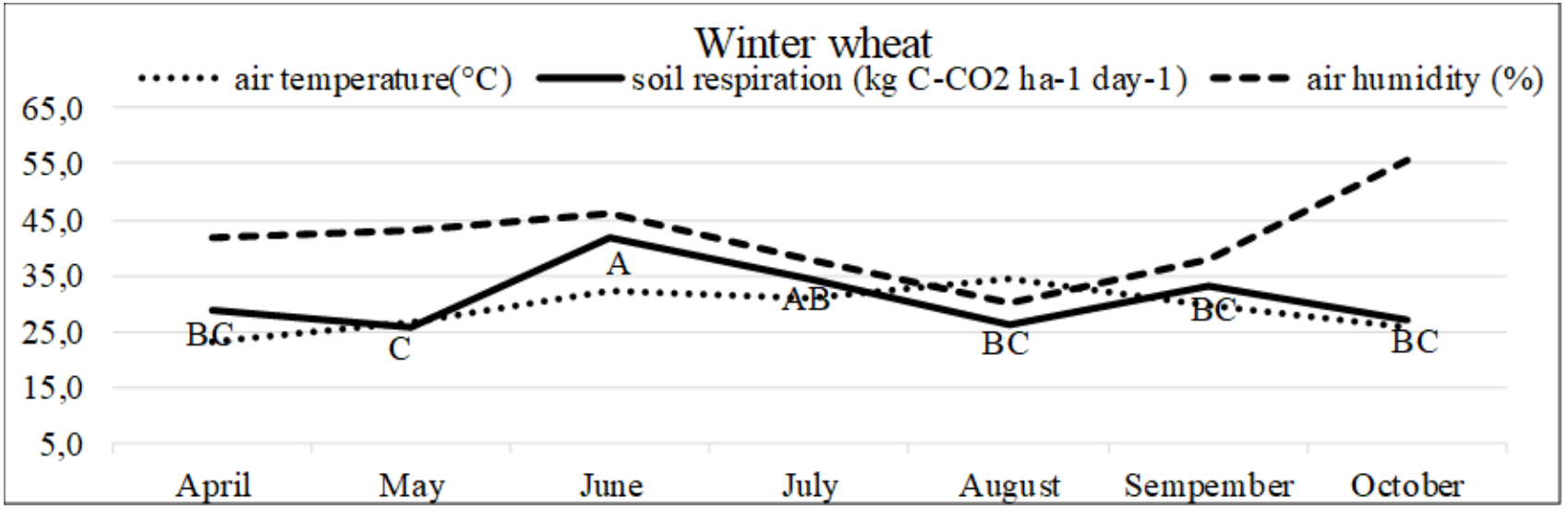
- relative air humidity:
  - 24 – 55%



# Results
## - temporal variation

Daruvar – winter wheat:

- soil respiration:
  - 25.6-41.8 kg C-$CO_2$ $ha^{-1}day^{-1}$
  - summer>autumn>spring (34.2>30.1>27.2 kg C-$CO_2$ $ha^{-1}day^{-1}$)
- air temperature:
  - 23.2-34.50°C
- relative air humidity:
  - 30 – 56%



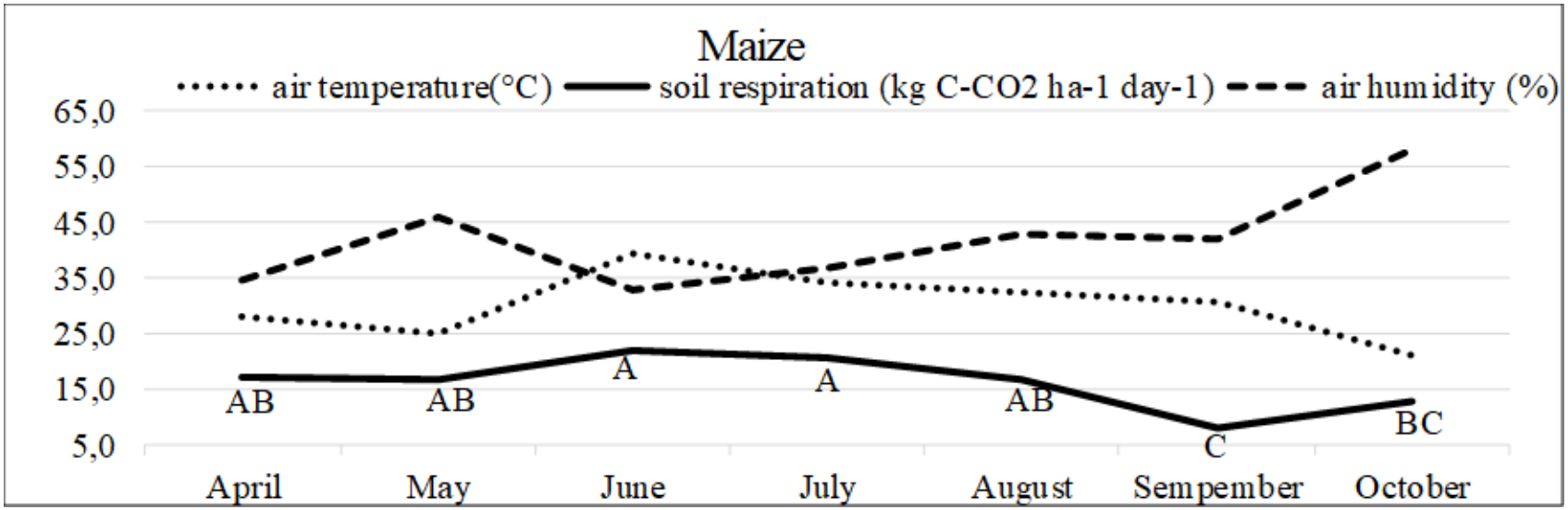
# Results
## - temporal variation

Potok - maize:

- soil respiration:
  - 8.0-22.1 kg C-$CO_2$ $ha^{-1}day^{-1}$
  - summer>spring>autumn (19.8>16.9>10.4 kg $ha^{-1}day^{-1}$)

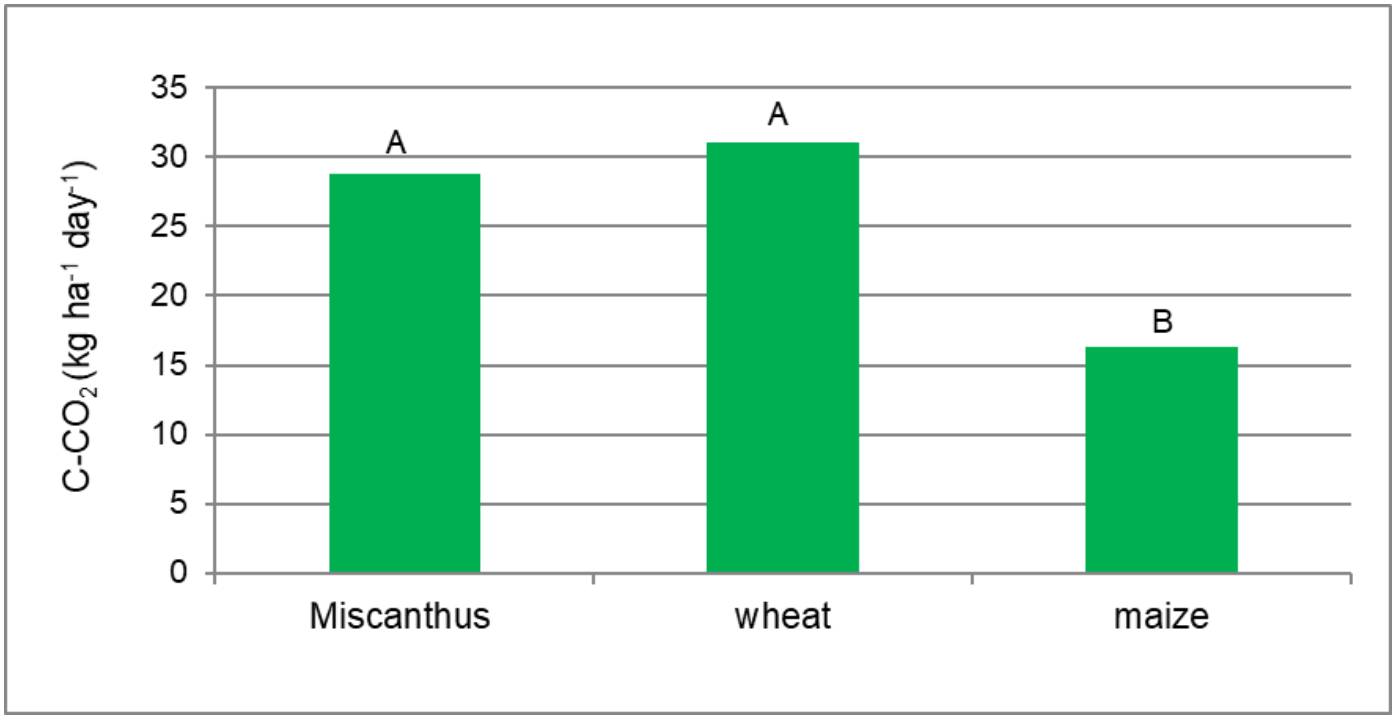
- air temperature:
  - 21.1-39.5°C

- relative air humidity:
  - 33 – 58%



# Results
## - average yearly soil respiration rates

- maize: 16.3 kg C-$CO_2$ $ha^{-1}day^{-1}$
- wheat: 31.0 kg C-$CO_2$ $ha^{-1}day^{-1}$
- *Miscanthus:* 28.8 kg C-$CO_2$ $ha^{-1}day^{-1}$



# Results
## - met. parameters - soil respiration

- According to determination coefficients, soil respiration under maize, wheat and *Miscanthus* depend respectively 4, 8 and 19% on air temperature.

- According to determination coefficients, soil respiration under wheat depends only 2% to relative air humidity while soil respiration under maize and *Miscanthus* depends respectively 42 and 53% on relative air humidity.

| | **soil respiration – air temperature** | | **soil respiration – relative air humidity** | |
|---|---|---|---|---|
| | **corr. coefficient** | **corr. strength** | **corr. coefficient** | **corr. strength** |
| ***Miscanthus*** | r=0.44 | moderate | r=0.73 | strong |
| **winter wheat** | r=0.29 | weak | r=0.14 | very weak |
| **maize** | r=0.21 | very weak | r=0.66 | strong |

# Conclusions

- a significant temporal variation of soil respiration has been determined for each crop type as well as significant difference in yearly soil respiration rates between maize and wheat/Miscanthus.
- greater influence on soil respiration has relative air humidity compared to air temperature.
- as soil respiration is site specific and is under the influence of many agroecological factors, further research is needed in order to better understand this complex issue.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