Preliminary investigation of greenhouse gas emissions from terraced fields in Malta

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Unique preliminary findings

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INTRODUCTION

Terraced fields on slopes is one of the common land management techniques used in Malta [1]. Besides improving land for agricultural use, effective erosion reduction is achieved. Yet, there is data scarcity about such land management in Malta in respect to related greenhouse gas (GHG) emissions. Data from arid and semi-arid regions are particularly scarce [2]. Scopus and Google Scholar were used to look for data about soil respiration or ecosystem respiration in Malta. Only one result from a lab experiment was found, and values about microbial respiration from four soil samples incubated in closed vessels, and solution of sodium hydroxide was used to absorb the released amount of CO_2 from soil. Our preliminary results will contribute to such emerging data and fill the existing gap.

OBJECTIVE

To fill data gap for GHG emissions from soils in Malta through conducting first direct field measurements using the SEMACH-FG chamber technique.

METHODOLOGY

The experimental site is located in Birżebbuġa, in the southeastern part of Malta (about 13 km west of Valetta; 35°48′N 14°31′E; ca. 40 m a.s.l.). The study was conducted on a site with two adjacent lands (1 and 2), separated by a rubble wall at different elevations. Both sites are under wheat cultivation for about 10 years with the same land management. CO_2 emissions were measured at three points at each site (A, B, C at site 1 and D, E, F at site 2). PVC collars were inserted in the soil at up to 5-cm depths 24 hours prior to measurement (Fig. 1). Soil emissions were measured daily from 20th to 23rd February 2018 with a manual dynamic closed chamber system (SEMACH-FG; Fig. 1). In addition, volumetric soil moisture content, soil temperature, air temperature, air pressure and relative humidity inside and outside the chamber were determined.

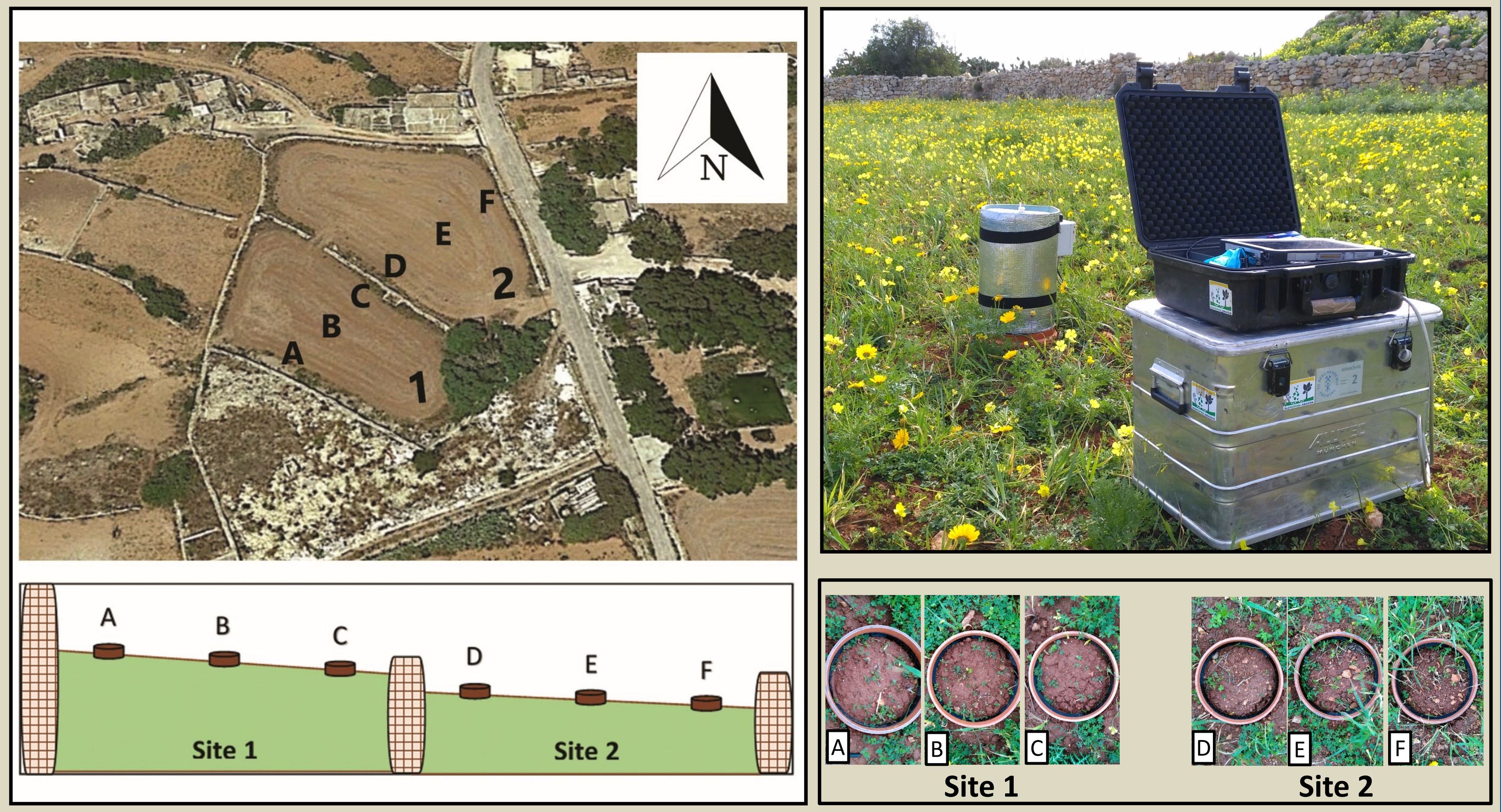

Fig. 1: Upper-left: Study site at Birżebbuġa (Google Earth Pro 2018); Lower-left: Field sketch; Upper-right: Manual soil respiration measuring system (SEMACH-FG); Lower-right: PVC collars.

RESULTS

Volumetric Soil Moisture Content (VSMC):

Site 1 has significantly higher soil moisture content than site 2 with a confidence level of 95.0% (Mann-Whitney test), averages of were 29.5±4.7 and 27.6±5.6% at sites 1 and 2, respectively (medians were 29.4 and 27.6%, Fig. 2). Site 2 has more stony surface than site 1, this might act as a physically seal reduces soil porosity and influences water-holding capacity.

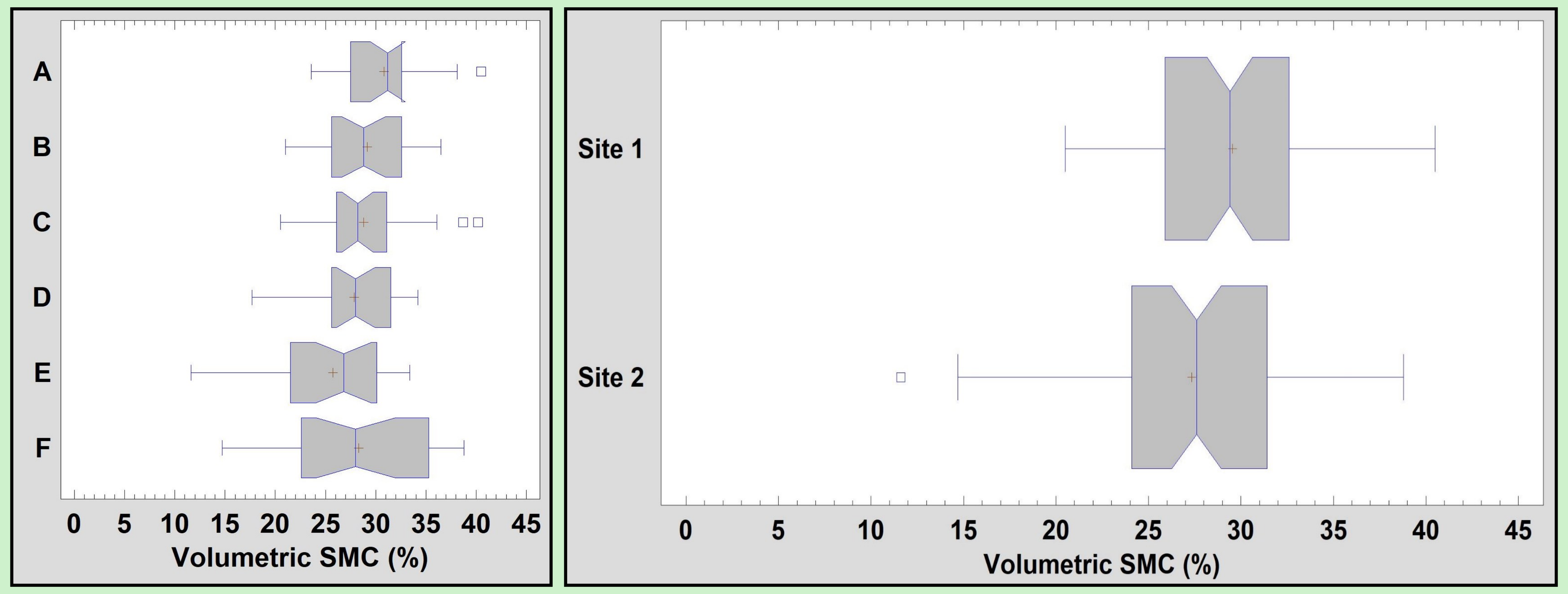

Fig. 2: Observed volumetric soil moisture content at measuring points A, B, C at site 1, and D, E, F at site 2.

CO_2 Soil Emission of:

Fifty-four determinations of emission rates were conducted at both sites. In general, rates ranged from 0.5 to 4.5 µmol CO_2 m^{-2} s^{-1} with an average emission of 2.27±0.9 µmol m^{-2} s^{-1} (median=2.44; Fig. 3). Our values are slightly higher than other values measured during the growing season under arid conditions (mean annual precipitation is 220 mm) in a Mediterranean-climate [3 and 4] with values between 1.15 to 1.93 µmol CO_2 m^{-2} s^{-1}, and less than agricultural lands under moderate climates such as in Germany (6.3 µmol CO_2 m^{-2} s^{-1}; Own data) and under wet tropical conditions such as in the Amazon basin (4.86 µmol CO_2 m^{-2} s^{-1}; Own data).

Emission of CO_2 from soils at site 2 was slightly higher than from site 1 (Mann-Whitney test, statistically significant at the 95.0% confidence level) with a release of 2.56±0.7 and 1.98±1.0 µmol CO_2 m^{-2} s^{-1} for site 2 and 1, respectively. (Fig. 3).

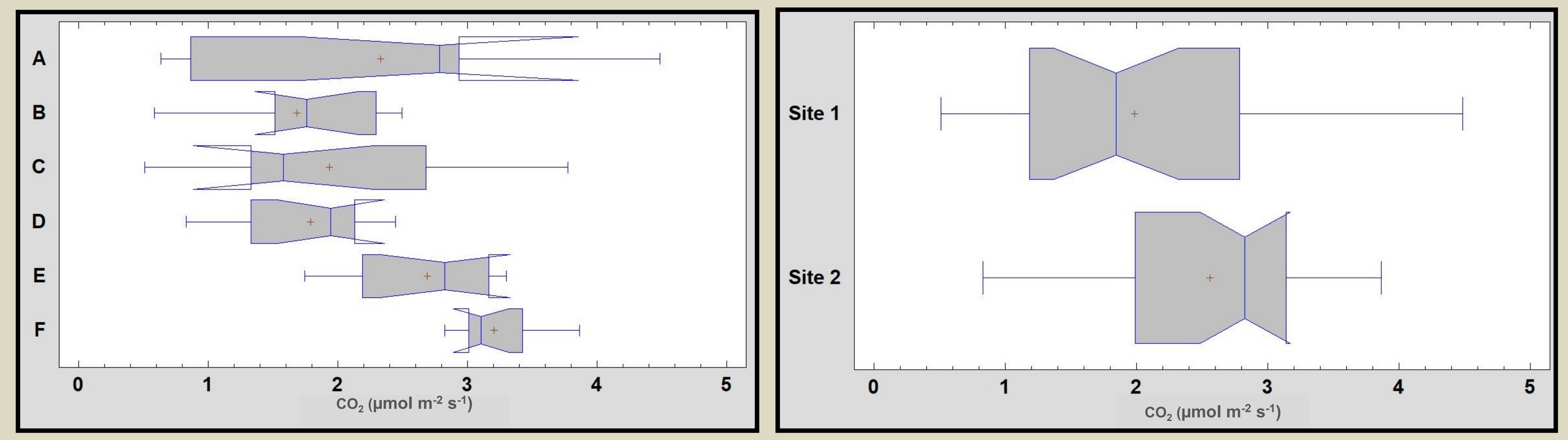

Fig. 3: Soil emission rate of CO_2 from measuring points A, B, C at site 1, and D, E, F at site 2.

Difference between medians of measuring points at site 1 (A, B and C) is not statistically significant, while at site 2 is significant between points *D* and *F* (Kruskal-Wallis test at the 95.0% confidence level). Furthermore, the lowest value for soil respiration was measured at point *D* which had lowest VSMC (20.6%), followed by point *A* which had highest VSMC (37.6%). Yet, results of soil geochemistry investigation would contribute to a better understanding of differences in soil respiration between the two sites.

CONCLUSIONS

From our preliminary investigation, we found that soil respiration rate at terraced fields in Malta is close to emission rates from agricultural lands in arid areas. Another investigation during dry season is highly recommended, because our current values represent rates during the wet season.

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REFERENCES:

1 Role A (2004) Experiences in Malta on the Management of Terraced Mediterranean Landscapes. SCAPE: 87-95
2 Oertel C, Matschullat J, Zurba K, Zimmermann F, Erasmi S (2016) Greenhouse gas emissions from soils—A review. Chemie der Erde - Geochemistry 76(3): 328-352
3 Oyonarte C, Rey A, Raimundo J, Miralles I, Escribano P (2012) The use of soil respiration as an ecological indicator in arid ecosystems of the SE of Spain. Ecological Indicators 14(1):40-49

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