Relating soil organic carbon variability to topography in olive orchards

Investigating the relationship between soil organic carbon variability and topographic factors at hillslope scale in three olive orchards under different soil management practices in Andalusia (southern Spain)

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MSc Thesis

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Relating soil organic carbon variability to topography in olive groves

INVESTIGATING THE RELATIONSHIP BETWEEN SOIL ORGANIC CARBON VARIABILITY AND TOPOGRAPHIC FACTORS AT HILLSLOPE SCALE IN THREE OLIVE ORCHARDS UNDER DIFFERENT SOIL MANAGEMENT PRACTICES IN ANDALUSIA (SOUTHERN SPAIN)

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ABSTRACT

This thesis explored the influence of olive orchard topography on soil organic carbon (SOC) distribution with the objective to research the certification potential for SOC sequestration in soils of olive groves in southern Spain. Orchard structure and soil management practices were the most important determinants for the SOC sequestration potential. Research to SOC variability within three different olive orchards showed different patterns, depending on soil management practices. Bare soil management leads to higher variability, while cover crop management reduces SOC variability throughout the hillslope. This pattern was also expressed similarly depending on the location of soil in each of the orchards: i.e. either under the tree canopy or in the lanes between tree rows. For the two orchards with bare soil management or sparse ground cover, the soil under tree canopy appeared to have higher SOC concentration in the top soil than soil in the lanes, while this difference was not found in the orchard with cover crop management. Regarding development towards sustainable olive cultivation, the introduction of cover crop management appeared to be a step forward. Although a distinction was made between soil management practices and topographical factors, these two factors interact strongly with each other; topography played a role regarding SOC variability when bare soil management was applied, but cover crop management proved to reduce the effect of topography on SOC distribution expressed in small variability at the hillslope scale and relatively equal distribution between the lanes and under the tree crown. Despite all efforts to explain SOC distribution, a high unexplained spatial variability still exists, which is attributed to a combination of several sources including: soil type and topography, orchard design, soil management practices, history, erosion and on-field activities. Therefore, certification for SOC sequestration could be supported by soil management practices and topographical factors, but cannot be fully based on only these two factors.

Key words: Soil organic carbon (SOC), distribution, variability, olive orchard, topography, erosion patterns, soil management practices

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1. INTRODUCTION

1.1 LAND DEGRADATION IN OLIVE ORCHARDS

Olive farming in Andalusia significantly intensified and encountered severe soil erosion problems in recent decades, resulting in soil fertility depletion, biodiversity loss and environmental degradation (Beaufoy, 2001). Soil quality and land degradation are closely linked to each other (Gómez et al., 2009a; Imeson, 2011). Regarding soil quality and sustainable agriculture, olive groves are highly vulnerable to soil degradation (Gómez et al., 2009b) due to a combination of topographic and climatic circumstances together with tillage practices. Olive orchards are generally located in sloping areas and planted at a low tree density (Soriano et al., 2012). Periodical torrential rainstorms, characteristic of the Mediterranean climate, cause ephemeral flush flows resulting in high soil erosion rates. Traditional tillage, maintaining a bare soil to avoid competition for scarce soil water between olive trees and natural vegetation, has greatly magnified soil erosion and degradation (Gómez et al., 2014). Due to these issues, alternative soil management practices have been developed in recent years, such as: reduced tillage, no-tillage, and use of cover crops or pruning residues to protect the soil (Gómez et al., 2014).

Soil organic carbon (SOC) is a key indicator of soil quality and agricultural sustainability (Reeves, 1997; Gómez et al., 2012) and it is identified as the most significant soil management variable impacting soil water availability and soil erosion (Bruce et al., 1995). SOC is an energy source for microbial processes such as respiration and biosynthesis (Reeves, 1997). Further, SOC reflects capacity for carbon sequestration in agricultural soils and has a positive impact on other physical, chemical and biological indicators of soil quality (Larson and Pierce, 1991; Reeves, 1997; Gómez et al., 2012). However, continuous and intensive cropping results in a decline in SOC which depends on cropping and tillage system, climate and soil. The rate and magnitude of SOC decline can be ameliorated by conservation tillage and crop rotations (Reeves, 1997; Gómez, 2009a).

Soil erosion and SOC content have been assessed in Andalusian olive groves in recent years (Gómez et al., 2009a; 2009b). No tillage combined with herbicides application appeared to be the soil management practice resulting in highest soil losses and runoff rates (Gómez et al., 2009a). The establishment of a vegetative cover reduced soil losses and runoff, while conventional tillage led to intermediate results regarding runoff and soil losses. Regarding SOC content, soils with vegetative cover appeared to have highest SOC values and no tillage combined with bare soil using herbicides resulted in lowest SOC values (Gómez et al., 2009a). The soil water balance appeared to be worst for no tillage with bare soil practice, since this management resulted in less infiltration and increased runoff losses.

Gómez et al. (2009b) studied soil degradation risk within the olive orchards, and compared soil management to SOC variability. Olive groves having similar soil types and tillage practices differed significantly in SOC values in previous surveys (Milgroom et al., 2007; Gómez et al., 2009b). At catchment and farm scale level, SOC presents also a large spatial variability, which complicates the evaluation of soil quality and the potential for carbon sequestration. This is probably related to the influence that agricultural activity and topography have on sediment transport (Van Oost et al., 2007). More research for the topographical component in SOC variability is needed to explain these differences.

The topographical component is represented by the surface profile of a landscape. Surface profile can be divided in waviness and roughness (MacDonald & Co, 2015). Waviness represents the basic shapes of the landscape, the geomorphologic structure of a landscape. Roughness represents the micro-topography of a surface. Both features influence the hydrological system and thus the flow paths of runoff. This mechanism also applies to erosion patterns; detachment, transport and deposition are strongly related to runoff flow. Erosion applies to soil particles; however, other components such as organic carbon are also prone to erosion.

As part of soil components, organic carbon is able to get detached and transported by runoff and being deposited in other areas. However, proper identification and accounting for the origin of eroded SOC at deposition sites remain limited (Stallard, 1998; Behre et al., 2007; Nadeu et al., 2012). During erosion processes, particle size redistribution is of great importance for SOC deposition. Soil particles are mainly transported as aggregates. Aggregates containing silt and clay particles are positively correlated to total organic carbon. Suspended organic carbon appears to be carried further away due to its binding to smaller mineral particles (Nadeu et al., 2011). SOC is therefore less correlated to coarse soil particles, resulting in slightly different distribution patterns. This distribution property should be kept in mind during the evaluation of the results.

Soil erosion is an important driver of SOC redistribution and sequestration. Leaching of SOC into deeper soil layers or water bodies is another way of losing carbon. Two mechanisms of SOC storage are controlled by soil erosion: redistribution in a catchment (from sources to sinks) and/or emissions to the atmosphere (from mineralisation of soil organic matter, SOM). In addition, SOC can turn into dissolved organic carbon which follows the path of runoff. Erosion leads to the modification of microbiological processes, water, air and nutrient regimes (Polyakov & Lal, 2003). Three processes of SOM loss caused by water erosion are: oxidation, due to aggregate breakdown during detachment and transport, transformation of SOM in a more stable pool and release of SOM into water bodies (Polyakov & Lal, 2003). Generally, mineralisation dominates in the first years after the start of cultivation, followed by SOC loss by erosion in later years. This is probably not the case in olive groves, since these are also prone to accelerated erosion in first years. There are some preliminary studies reporting high SOC losses associated with runoff and sediment losses (Gómez et al., 2012b).

SOM can be divided into three pools: labile compounds or active pool, slow pool, and stable SOM pool (Rice, 2002). Soils in depositional sites usually contain a larger proportion of total organic carbon in labile fractions of soil carbon since this material can be transported easily. The burial of this labile carbon would result in increased carbon stocks. On the other hand, erosion mainly leads to the loss of land productivity resulting in a reduced quantity of organic carbon returned to the soil (Gregorich et al., 1998). Besides, moister environments at lower slope sites results in increased plant production and so an increase of carbon into the soil (Aandahl, 1948).

Not many studies are known where the effect of topographical factors on SOC variability were assessed, but applying an erosion model to explain SOC variability within a catchment appeared to be an applicable tool. This is the case, for instance, of the WaTEM/SEDEM erosion model (Van Oost et al., 2000; Van Rompaey et al., 2001; Verstraeten et al., 2002; Brunner, 2012), which has been used to assess its applicability to explain SOC variability by erosion and deposition patterns by Dlugoβ (2011). In this study was concluded that: "Correlations between SOC and tillage erosion and total erosion are positive in each soil layer and in each raster width indicating an accumulation of SOC on depositional sites and a loss of SOC on eroding sites".

1.2 PROBLEM STATEMENT

Soil organic carbon has a strong spatial component, which is probably related to the influence that agricultural activity and topography have on sediment transport and redistribution (Van Oost et al., 2007; Gómez et al., 2012b). This complicates the evaluation of soil quality and its interpretation for potential carbon sequestration. As a result, evaluating soil quality of olive farms by appraising its soil management appeared to be complicated due to the large soil spatial variability within olive orchards (Gómez et al., 2009b). This research is set up to investigate the possibility of improving classifying olive farms by evaluating the hypothesized relation between SOC variability and the topographical component within an olive orchard. Complemented with a good understanding of soil management it could be helpful in achieving a better interpretation of the soil degradation state, or eventually of the improvement of its soil quality with a limited number of measures.

1.3 HYPOTHESIS

SOC variability within a hillslope in an olive grove could be explained by topographical factors and erosion and deposition patterns combined with tillage and other soil management practices, using the erosion/deposition model Watem/Sedem and statistical analyses.

Land management and topography are expected to have a large effect on SOC content and its distribution on hillslope scale. Therefore, this hypothesis will be tested by doing this investigation at three study areas having different olive orchard conditions. This makes it possible to do mutual comparisons in modelling outcomes between current soil management practices and olive orchard management history. In this way, the possible influence of topography and soil type in the interpretation of a key indicator of soil quality (i.e., SOC) will be evaluated.

1.4 RESEARCH QUESTIONS

1.4.1 MAIN RESEARCH QUESTION

In which way do topographical factors determine the spatial distribution of soil organic carbon in three olive orchards in Andalusia, having different soil management practices?

1.4.2 SUB-RESEARCH QUESTIONS

- How is Soil Organic Carbon distributed in the study areas, and are distribution patterns recognisable?
- Is there an identifiable spatial pattern of SOC that could be related to redistribution of soil caused by water erosion?
- Can SOC content distribution in the study areas be quantified by means of the results of erosion patterns generated by Watem/Sedem?
- Is it possible to classify land degradation on the basis of SOC variability explained by erosion and deposition patterns?
- Which other topographical factors affect the SOC variability?
- What are other non-topographical and non-soil management factors influencing SOC variability within the study areas?

- What are the possibilities for certifying olive orchards for sustainable management based on the outcomes of this research?

1.5 Report outline

This report goes through several sections, each addressing different research questions. The methodology is explained in chapter 2, containing study area description, description of SOC analysis and data interpretation, total SOC calculation and the use of Watem/Sedem for erosion modelling, finished by the method description of linking SOC distribution to topographical components. Chapter 3 contains the results, divided in SOC concentrations and spatial trends, Total SOC and its spatial trends and the analysis of the influence of topographical factors on SOC distribution. Discussion and recommendations for further research are presented in chapter 4. In chapter 5, the conclusions are provided, summarizing the main findings of this research.

2. METHODOLOGY

2.1 STUDY AREAS

This research is carried out in three olive groves located in '*Campiña Sur*' of Córdoba, an agricultural area located in the Guadalquivir River valley, Andalusia (Spain) (Fig. 1a). The Guadalquivir River is located in the region of Andalusia and begins in the Cazorla mountain range. *Campiña Sur* is a rolling landscape which is extensively used for agricultural production. Common crops are olives, cereals (mostly wheat) and sunflower. Andalusia is characterized by its Mediterranean climate featured by hot and dry summers, and an average annual rainfall amount of 500-600 mm which generally falls between November and April, with sporadic severe rainfall events. Annual average temperature is 16°C (Soriano et al., 2012).

Figure 1: a) Andalusia, southern Spain (Google Maps, 2015). b) The location of the study areas situated in 'Campiña Sur': Matasanos (green), La Teja (blue) and Nicolás (red) (Google Earth, 2015); they are displayed in figures 2-4.

The study areas are located in the southern part of Córdoba province (Fig. 1b). To identify the three study areas (a hillside in each olive grove), they are named with the name of each farm: Matasanos, La Teja and Nicolás. These study areas differ in olive orchard characteristics and management.

'Matasanos' is an irrigated olive orchard intensively cultivated where trees form a hedgerow, planted at a frame of 7m×5m between and within the rows (Fig. 2a&b). The lanes contain a cover crop of 4-m width. The area, previously in production for rainfed arable crops as sunflower and wheat, was turned into an olive grove in 2007 since this would be economically more profitable. The current soil management consists of non-tillage with a cover crop. The harvest is during November and December. Herbicides (Glyphosate and MCPA) are yearly applied on the areas under tree canopy after harvest. A bare soil under the trees is maintained to avoid competition for water and nutrients from natural vegetation. Fertilisation is applied twice a year by fertigation.

The cover crop is dense and high and is mowed in July when the birds' nests are left (Fig, 2b). Occasionally, the cover crop is mown in February or March before nesting, depending on the vegetation growth and rainfall of the season. The cover crop type is annual Ryegrass, and it was sown at the start of the plantation and it has self-sown since that date. To date, there are other grasses and broad leave weed species present in the cover crop although Ryegrass still is the dominant grass specie. The cover crop soil management was adopted since the start of the plantation. The reasons for applying the cover crop is to prevent erosion, to improve soil properties, to facilitate access to the orchard since it improves machinery traffic after rainfall, and to maintain an attractive habitat for birds.

On average, the soil texture is 47% silt, 46% clay and 7% sand (0-10 cm depth), and is classified as a Vertisol according to FAO classification. Its altitude varies between 185m to 140m above sea level, and slope steepness ranges from 1.5° to 16.5°.

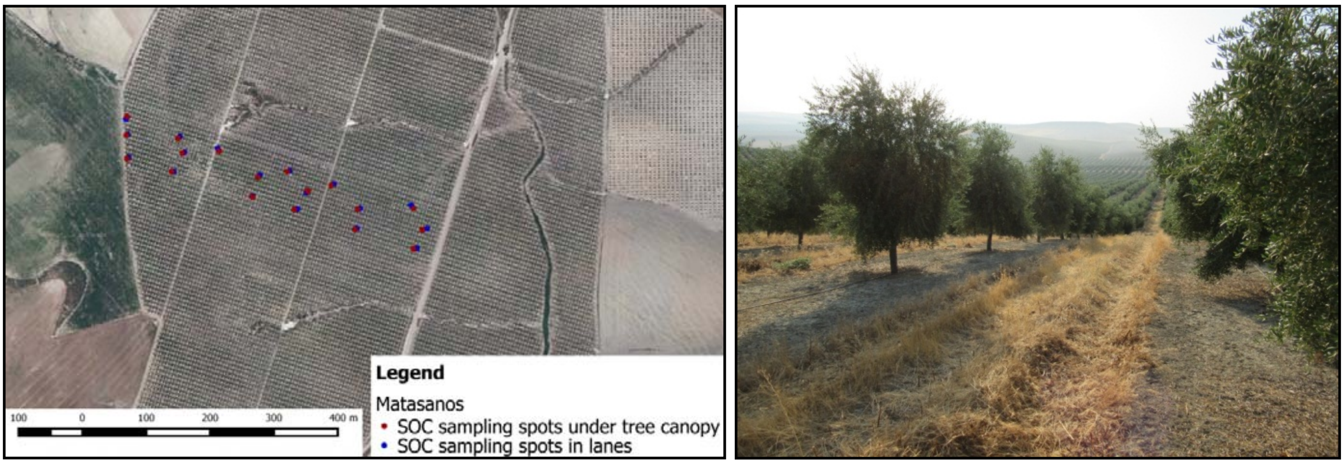

Figure 2: a) Olive orchard 'Matasanos' with soil sampling spots distributed over three transects along the hill slope. b) A view of the hilly olive orchard. It is shown the dense cover crop in the lanes alternated by bare soils under tree rows.

'La Teja' has olive trees planted at a spacing of 6-m in the rows. The spacing between tree rows is 8-m (Fig. 3a&b). This olive grove was planted in 2005. In the past cereals and sunflower were grown in the plot. The shift to an olive grove was due to economic reasons. Besides, the soil was more suitable for olives. Olives are harvested in November. Drip irrigation is applied from April to September and fertilizers are applied by fertigation supplemented with foliar fertilizer.

One of every two lanes a cover crop of 3-m width was started to be sown in November 2014 (Fig. 3b). Prior to the cover crop seeding, soil management was bare soil through periodic tillage. These lanes, the ones with bare soil never sown, were the ones included in this study. The cover crop started to be applied to prevent soil erosion and also to improve water retention in the soil. At present, herbicides (Glyphosate and Oxifluorfen) are applied only under the tree canopy, after the first autumn rains.

Averaged soil particle classes (0-10 cm depth) were 33% silt, 27% clay and 40% sand. The altitude ranges from 220m to 275m above sea level and the slope steepness ranges from 1° to 16.5°.

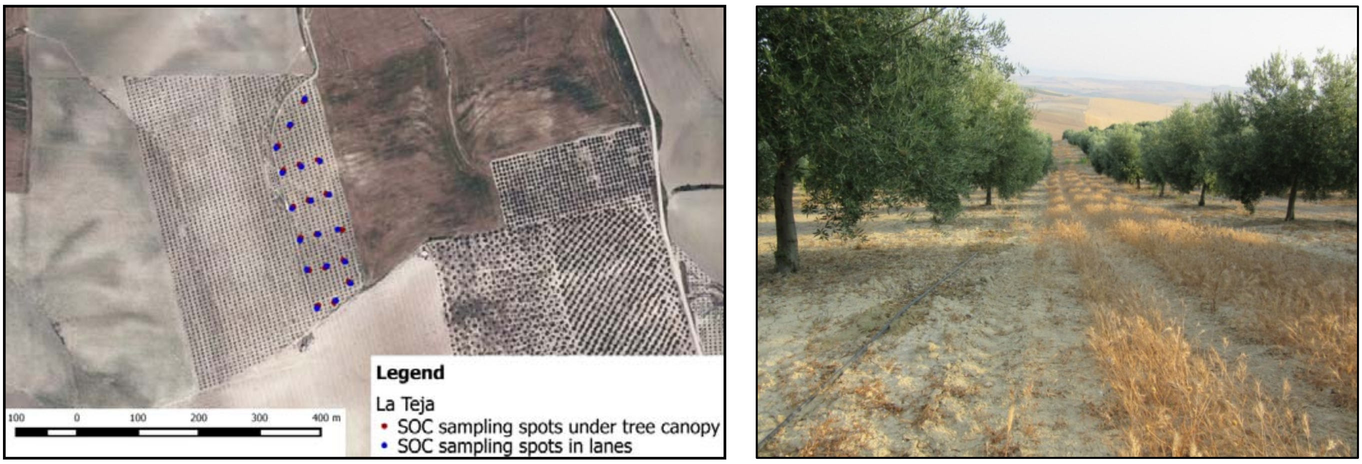

Figure 3: a) Olive orchard 'La Teja' with soil sampling spots distributed over three transects. b) View of the olive orchard showing the cover crop and bare soil under the tree canopy.

'Nicolás' is a rain-fed olive grove which was planted in 2000, having a square tree frame of 8×8 m^2 (Fig. 4a&b). In the past, in this area rain-fed arable crops were grown, such as sunflower and wheat, changing to olive grove was due to economical reason. No tillage is applied in this orchard.

In February or March herbicides (Glyphosate) are applied to remove sparse natural vegetation, and foliar fertilisers are applied during spring. The major problem faced by the farmer is the limited infiltration of rain water; during rainfall events, runoff appears easily. According to the land owner, differences in olive yield are recognised, and this is explained by soil water availability, soil fertility and slope of the terrain.

The soil contains 52% silt, 30% clay and 18% sand, and is classified as Vertisol according FAO classification. The altitude differs between 235m and 215m above sea level, slope ranges between 1.5° and 17°.

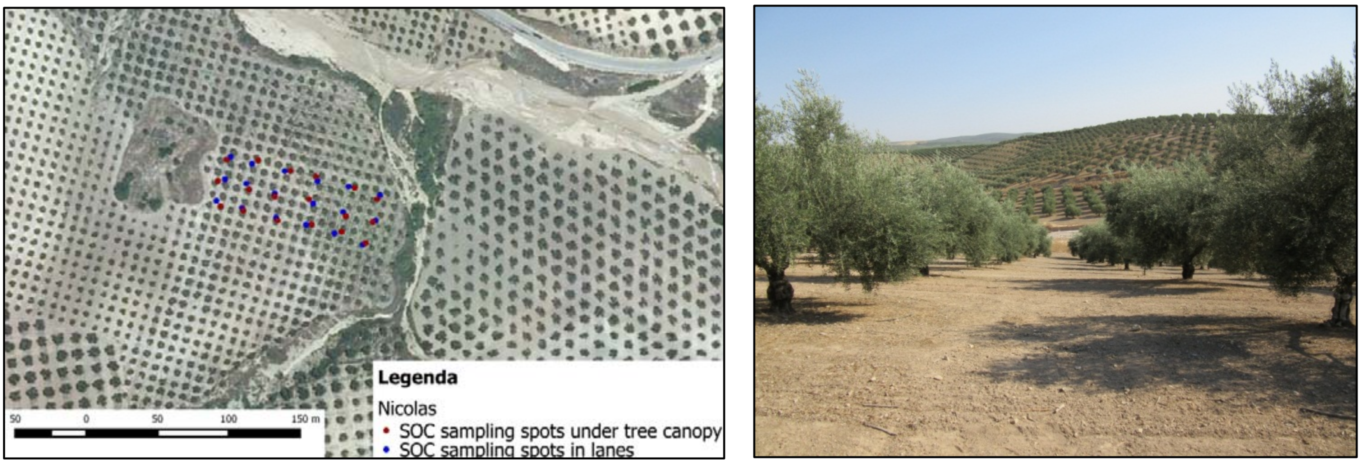

Figure 4: a) Olive orchard 'Nicolás' where soil sampling spots are located on a hill slope, bounded by a plateau on the top (west-side) and a gully down the slope. b) View of the orchard where bare soil is maintained and trees are placed in a square frame.

2.2 SOC ANALYSIS

2.2.1 SOIL SAMPLING

The SOC determination is based on soil samples taken from the study areas. Sampling was carried out between March and April 2015 in the three olive orchards, and samples were taken for the top 1-meter of the soil, divided over four layers: 0-15cm, 15-30cm, 30-60cm and 60-100cm. Separate sampling was made in two different locations in each of the orchards: tree rows (under tree canopy) and between tree rows (lanes). In each orchard a representative slope was chosen. For each representative slope, six transects (three in the lanes and three under tree canopy) were made, each one with six sampling points at approximately constant distance from the top to the bottom of the slope. So for each orchard thirty-six sampling points were taken. In total, for each study area, or olive orchard, 144 (= 2 areas × 3 transects × 6 sampling points × 4 soil layers) soil samples were taken.

2.2.2 SOC DETERMINATION

The method to quantify OC concentration in soil was based on the Walkley-Black procedure (Walkley and Black, 1933). This OC determination is based on titrations; an indicator solution added to a pre-prepared soil sample causes a colour change. The amount of added indicator solution is in proportion to the SOC concentration in the sample (Figs. 5a & b).

Figure 5: a) The SOC determination by manual titration and b) the colour change from blue to green.

2.2.3 SPATIAL VARIABILITY OF SOC

To visualise the spatial variability of SOC concentration in the top 15-cm of the soil in the study areas, a fully covered area of SOC content was calculated by interpolation of normalised SOC concentration. This normalisation consists of dividing the SOC values by the SOC average value of the sampling area (each location) in each olive orchard. Spatial maps were created by interpolation of normalized values of both sampling areas in a relative scale from 0 to a positive value. The GIS software used for the spatial analysis is Quantum GIS. The chosen interpolation method for the creation of SOC variability maps is Inverse Distance Weight (IDW) which excludes other influencing topographical factors. In addition to this observation method, SOC concentration, slope gradient and erosion in each transect was visualised in graphs. Data and analysis are shown in appendix 1-5

2.2.4 TOTAL SOC

The total amount of SOC (TOC) in the top 1-meter of the soil was calculated according to the SOC concentration and soil bulk density. The ratio of gravel (>2mm) was not incorporated into the calculations because the coarse material content was negligible Again a distinction was made according to soil in the lanes and under the tree canopy to determine bulk density. For each sampling spot, a total organic carbon calculation was carried out according to equation 1a&b.

$$TOC\ (g/cm^2) = (\%OC/100 \times \text{bulk density}\ (g/cm3) \times \text{soil layer}\ (cm)) \qquad \text{Eq. 1a}$$

$$TOC\ (t/ha) = SOC\ (g/cm^2) \times (((10^4 \times 10^4)) / (10^3 \times 10^3))) \qquad \text{Eq. 1b}$$

Further, tree canopy cover was measured to be able to calculate the proportion of soil under the tree rows within each study area. It is assumed that only the soil under tree canopy represents this sampling area. Canopy cover was determined according to measurement of the tree crown radius, in six trees at random in each study area. The number of trees in a set area combined with an average canopy cover set the proportion of soil under tree canopy in the entire study area. Calculations can be found in appendix 6. Based on that, the proportion of SOC (and TOC) under tree canopy and in the lanes was calculated. A summation of both TOC values resulted in an overall TOC amount for the study areas (in tons per hectare) Results are shown in appendix 7.

2.3 WATEM/SEDEM MODELLING

2.3.1 MODEL EXPLANATION

A method to investigate erosion patterns is to apply physical or empirical erosion models. In this research the empirical-based, spatially distributed soil erosion and sediment delivery model Watem/Sedem was applied (Van Oost et al., 2000; Van Rompaey et al., 2001; Verstraeten et al., 2002; Brunner, 2012). Watem/Sedem was developed at the Physical and Regional Geography Research Group at K.U. Leuven, Belgium. It was developed to simulate the impact of soil conservation and sediment control measures and land use changes (Notebaert et al., 2006). Watem/Sedem can be applied at small catchment and regional scale. This model simulates transport and deposition within a drainage basin, focusing on spatial variability and estimates spatial patterns of soil loss and sediment flow. Two modules are integrated; water erosion prediction (Watem) and sediment delivery (Sedem) (Van Oost et al., 2000; Van Rompaey et al., 2001). Soil erosion calculations are based on the Revised Universal Soil Loss Equation (RUSLE) (Renard et al., 1997). The model uses a sediment transport capacity equation and cascading transport model (Van Rompaey et al., 2001). Watem/Sedem is a grid-based model using IDRISI GIS software. For this research version 2005 was used.

2.3.2 INPUT MAPS

Due to the empirical character of the Watem/Sedem erosion model, a limited input of data is needed. A digital elevation model (DEM) and a Parcel map, which represent the topography of the study areas, were required. The DEMs (5m*5m resolution) are based on Lidar data from CNIG (Centro Nacional de Información Geográfica) of the Ministry of Public Works and Transport. The catchments were determined based on calculations of flow directions and accumulations in GIS. The delineation of the upper boundary of the slope in 'Nicolás', created by the remnants of an old building, was checked at the field with GPS with centimetre spatial resolution.

2.3.3 *Revised Universal Soil Loss Equation*

The Revised Universal Soil Loss Equation (RUSLE), developed by Renard et al. (1997), is an erosion model designed to predict long-term average annual soil loss caused by runoff, depending on specific field slopes, crops and management systems (eq. 2). USLE was the precursor of RUSLE which was developed by Wischmeier and Smith (1978). The average long-term annual soil loss (A) of a catchment is calculated according to the following equation:

$$A = R \times K \times L \times S \times C \times P \qquad \text{Eq. 2}$$

where A (t ha^{-1} yr^{-1}) is the average annual soil loss, R (MJ mm ha^{-1} h^{-1} yr^{-1}) is a rainfall erosivity factor; K (t ha h ha^{-1} MJ^{-1} mm^{-1}) is soil erodibility; L is the slope length factor, S is the slope steepness factor; C is the land use and management factor and P is the effect of soil conservation measures factor. These factors are dimensionless.

The topographical factor (LS) is represented by the slope length factor (L) and slope steepness factor (S). This algorithm uses the DEM and parcel map and is developed by Desmet and Govers (1996) and improved by Takken et al. (2001) L is the ratio of soil loss from the field slope length to that from a 72.6ft length under identical conditions. S is the ratio of soil loss from the field slope gradient to that from a 9% slope under otherwise identical conditions (Wischmeier & Smith, 1978).

Several LS algorithms are incorporated in Watem/Sedem (Wischmeier and Smith, 1978; McCool et al., 1987; Govers, 1991; Nearing, 1997):

Nearing (1997) was able to develop a slope steepness function which is applicable for all slopes and is consistent with RUSLE relationships (eq. 3).

$$S = -1.5 + \frac{17}{(1+exp(2.3-6.1\,sin\,ø))} \qquad \text{Eq.3}$$

Nearing's equation gives better results for steeper slopes (Nearing, 1997). Since steep slopes are present in the study sites and it has been demonstrated that this equation also gives reliable results for calculations on shallow slopes, Nearing's equation was used in this study.

The Soil erodibility factor (K) is calculated according the equation of Renard et al. (1997) (eq. 4).

$$\mathrm{K} = \left(\left(\frac{0.00021\times \mathrm{M}^{1.14} * (12-OM)}{100}\right) + \left(\frac{3.25\times(Csoilstr-2)+2.5\times(\,Cperm-3)}{100}\right)\right)\times 0.1317 \qquad \text{Eq. 4}$$

Where M is the textural factor

$$\left(M = (\mathrm{M\ silt} + \mathrm{M\ very\ fine\ sand})\times(100 - M\ clay)\right) \qquad \text{Eq. 5}$$

M_{silt} is silt fraction content (0.002-0.05mm)
$M_{very\ fine\ sand}$ is very fine sand fraction (0.05-0.1mm)
M_{clay} is clay fraction (<0.002mm)
OM is organic matter content (%)
$C_{soilstr}$ is the soil structure class (1: very fine granular, 2: fine granular, 3: medium or coarse granular, 4: blocky, platy or massive)
C_{perm} is the permeability class (1: very rapid, 2: rapid, 3: moderate, 4: fairly slow, 5: slow, 6: very slow)

The land use and management factor (C) is determined by the actual soil management. Based on the findings of the RUSLE calibration in olive orchards in previous research by Gómez et al. (2003), an estimation of this factor is made for each study orchard. The C factor decreases as soil cover increases and when the number of soil treatments increases due to an increase in soil roughness. C is also depending on the tree canopy size.

2.3.4 *Model calibration*

In our study, we evaluated predicted sediment losses with those measured in analogous situation in previous studies since direct measurements of sediment losses from the study area were not available. In our case we used as benchmark values those measured by Vanwalleghem et al. (2011). Calculating the RUSLE factors which are the input parameters in Watem/Sedem was the method to calibrate the models. Since the circumstances of olive orchards differ from other agricultural land uses, the calibration is carried out according a previous RUSLE calibration of olive orchards (Gómez et al., 2003). Some parameter values are calculated according to equations representing soil management practices and soil properties; others are derived from previous results. Validating the models was impossible due to the absence of on-site erosion measurements. This calibration procedure insures that simulated values are within the range of observed rates in analogous situations in the region. As a result, the outcomes, although are more or less uncertain in absolute values, can provide a reliable indication of erosion and deposition patterns within each slope and can be compared among sites in relative terms.

2.3.5 *General inputs Watem/Sedem*

Rainfall erosivity factor (R) is set at 0.085 MJ mm m^2 h, according to Gómez et al. (2003), since the study areas are located in the same region, the climatic circumstances are assumed to be equal. Rainfall erosivity is based on a daily rainfall record for Córdoba from 1953-1996 following the approach of Giráldez et al. (1989), using daily rainfall.

$$Ei = 0.0682\ P^{1.998} \qquad \text{Eq. 6}$$

2.3.6 *Specific inputs: Matasanos*

All erosion in Matasanos is caused by water erosion since tillage is not incorporated in the orchard operations. The cover management factor (C) is chosen according to Gómez (2003). In the case of Matasanos, a value is chosen, assuming an average canopy radius of 2.5m^2, between a cover crop of four meter (0.16) and full cover crop (0.06). Due to the uncommonly high density of the cover crop it is assumed that the C factor should be lower than 0.16. On the other hand, it is not a full coverage of the soil which resulted in a concession of these two values: 0.10.

R	0.085 MJ mm m^2 h
K	30 kg m^2 h MJ^{-1} mm^{-1}
LS	Nearing
C	land use and management: 0.10
P	soil conservation measures: 1

2.3.7 *Specific inputs: La Teja*

La Teja has other soil conditions than Matasanos. A cover crop was applied in the last year and only outside the sampled area. So we categorize this study area as conventional tillage and herbicide use. Again, it is assumed that the average canopy radius is 2.5-m^2, the value of land use and management factor is set at 0.40 according to Gómez et al. (2003).

R	0.085 MJ mm m^2 h
K	35 kg m^2 h MJ^{-1} mm^{-1}
LS	Nearing
C	land use and management: 0.40
P	soil conservation measures: 1

2.3.8 *Specific inputs: Nicolás*

Nicolás is the study site without a cover crop, but with the growth of sparse natural vegetation, killed in late winter. An almost bare soil is maintained which results in a high land use and management factor: 0.45; a higher C value is chosen (higher than 0.40 for conventional tillage) due to compaction and low surface roughness.

R	0.085 MJ mm m^2 h
K	52 kg m^2 h MJ^{-1} mm^{-1}
LS	Nearing
C	land use and management: 0.45
P	soil conservation measures: 1

2.3.9 *Model output*

Watem/Sedem generates spatial maps. It separately calculates tillage erosion and water erosion. As a result, total erosion and deposition amounts are represented in a map, showing an erosion quantity for each grid cell in t/ha. Total erosion and deposition are calculated. Its difference is the sediment amount which has left the catchment.

2.4 Relating topographical components to SOC and TOC

The next step was to correlate SOC concentrations to topographical factors. Visually, erosion and deposition patterns were compared to SOC concentration in the first 15-cm of the soil layer and TOC content in the top 1-m of the soil.

In search for correlations between topographical factors and SOC and TOC, box-plots were created to quantify trends. Deposition rates, slope gradient and surface altitude were represented and compared to SOC concentration and TOC in each sampling area and soil layer. This analysis was followed by multivariate analysis of variance (ANOVA) to determine whether there are significant differences in the SOC and/or TOC attributable to different independent variables or main factors (Laerd Statistics, 2016).

For SOC an ANOVA was carried out for each soil layer. This analysis brings out correlations between topographical factors and SOC and TOC variances. When the significance level is $P<0.05$, a significant difference in dependent variables (SOC concentration; TOC content) between treatments or levels of the independent variable is assumed. The detailed outcomes of ANOVA are presented in appendix 8.

ANOVA was applied with the following main factors: farm or study area, sampling area (line & under trees canopy), slope steepness (>30% & <30%), erosion/deposition areas and erosion (>20t/ha/yr. & <20t/ha/yr.). The use of classes instead of correlations was due to the limited number of sampling points. Erosion at 20 t/ha was chosen on the basis as been approximately the double of the maximum tolerable soil loss rate of 11.4 t/ha/yr. for a rooting depth of 150-cm for olive trees (Gómez et al., 2003). Doubling this maximum tolerable soil loss could reveal a possible trend between erosion rates and SOC concentration.

2.5 Interviews

Since other non-topographical factors could explain the SOC distribution, other causes of SOC content variability were investigated by means of interviews with the land owners. Questions about previous land management could support the findings of SOC variability. The answers are documented in the study area descriptions and in the discussion.

3. RESULTS

3.1 SOIL ORGANIC CARBON DISTRIBUTION

3.1.1 SOIL ORGANIC CARBON CONCENTRATION

All results of the SOC analysis are shown in appendix 1. Table 1 shows the average SOC concentration and standard deviation per soil layer for the two sampling areas (under trees and lanes) and three study areas. The vertical distribution of SOC shows a similar pattern for all three olive orchards. SOC concentration is highest in the top 15-cm of the soil and decreases as soil depth increases. Regardless of the presence or not of cover crops, this decrease appears in every study area. Matasanos has a higher overall SOC content, followed by Nicolás. La Teja appeared to have lowest SOC content. Another conclusion is that soil beneath canopy contains higher SOC concentration compared to the adjacent lane area, except for Matasanos. Box-plots of SOC concentration are presented in appendix 2. Results from the statistical analyses to determine significant differences are presented in appendix 3.

Table 1: Average SOC concentration (%) and standard deviation, for the three study areas and two sampling areas (lane and under trees canopy). Values marked in bold and underlined indicate highest average value among sampling areas.

Olive orchard	Soil layer (cm)	0-15		15-30		30-60		60-100	
	Sampling area	Lane	Canopy	Lane	Canopy	Lane	Canopy	Lane	Canopy
Matasanos	SOC (%)	**<u>0,82</u>**	0,78	0,58	**<u>0,62</u>**	**<u>0,48</u>**	0,47	0,36	**<u>0,39</u>**
	St Dev	0,21	0,14	0,06	0,14	0,08	0,07	0,07	0,10
La Teja	SOC (%)	0,42	**<u>0,55</u>**	0,31	**<u>0,42</u>**	0,20	**<u>0,24</u>**	0,15	**<u>0,18</u>**
	St Dev	0,14	0,17	0,19	0,16	0,15	0,16	0,12	0,15
Nicolás	SOC (%)	0,65	**<u>1,04</u>**	0,33	**<u>0,53</u>**	0,26	**<u>0,29</u>**	0,17	**<u>0,20</u>**
	St Dev	0,26	0,26	0,16	0,18	0,18	0,12	0,08	0,07

In search of differences of SOC concentration between sampling areas (in lanes and under canopy) it is apparent that in most orchards this distinction has to be made. Table 2 shows that in the top soil layer of La Teja and Nicolás, SOC concentrations were significantly different between the sampling areas. Even in the second layer (15-30 cm below surface) a clear distinction exists, significant in Nicolás.

Table 2: Summary of significance assessment of SOC concentration for each soil layer among the two sampling areas (line and under trees canopy); T-tests are presented in appendix 3.

Significant difference (*P*<0.05) of SOC (%) between sampling areas	Study area		
Soil layer (cm)	Matasanos	La Teja	Nicolás
0-15	No	Yes	Yes
15-30	No	No	Yes
30-60	No	No	No
60-100	No	No	No

3.1.2 SPATIAL TRENDS

Each study area has a different SOC distribution pattern. This basically indicates the spatial component of geomorphic processes coupled with management. The distribution of SOC along transects are shown in appendix 4. Interpolation maps of SOC concentration in deeper soil layers are shown in appendix 5.

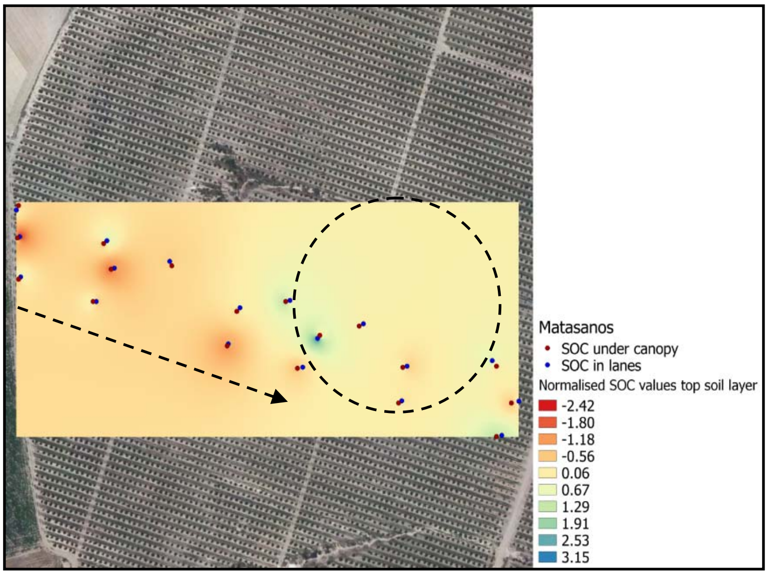

Figure 6: Map of the IDW interpolation of normalised average SOC values in the top soil layer (0-15 cm).

In Matasanos (Fig. 6), a small transition of SOC contents is visible: from a trend of lower SOC values in the upper part of the hill slope (on the left side of the study area) to a moderate trend of higher SOC values in the down-slope part of the hill slope, located in the dashed circle. The dashed arrow indicates the slope direction. The range from 0.33% (-2.42) to 1.37% (3.15) is relatively small which shows a minor transition on the slope.

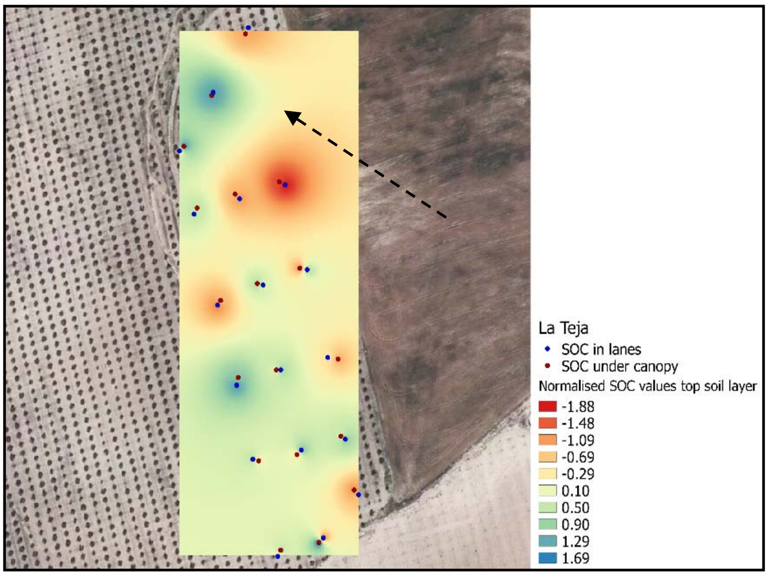

Figure 7: Map of IDW interpolated normalised average SOC values in the top 0-15 cm of the soil in La Teja.

In La Teja (Fig. 7), the SOC pattern is not as clear as in Matasanos, but lower SOC values are predominantly found in the east side of the study area. The western part and downhill has predominantly higher SOC values. The dashed arrow indicates the slope direction

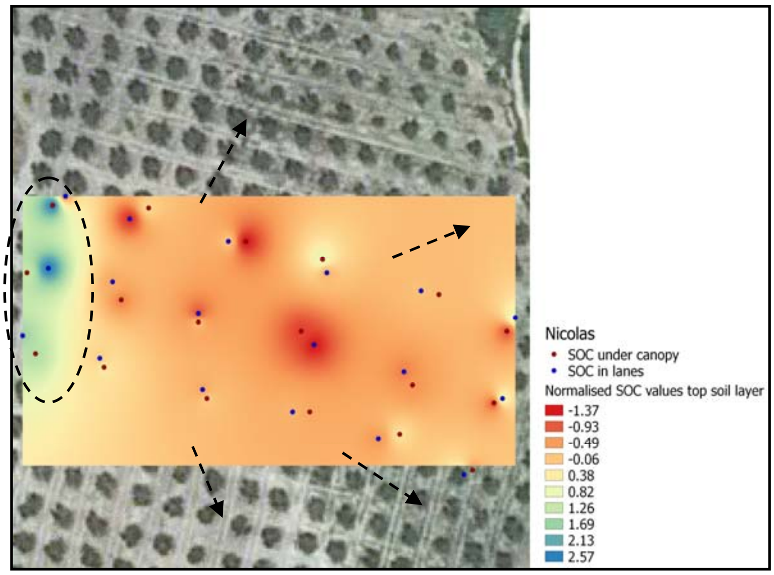

Figure 8: Map of IDW interpolated normalised average SOC values in the top 0-15 cm of the soil in Nicolás.

Figure 8 shows the results for Nicolás. This study area has the largest range of SOC values. In the top of the slope, a plateau in the western part (dashed oval), the SOC values are highest. The steeper slope, in the middle of the sampling area, contains the lowest SOC values. For the lanes it seems that the SOC values start to increase in the lower areas of the slope, located in the east which could indicate some deposition of SOC.

3.1.3 TOTAL ORGANIC CARBON

Instead of focusing on the top soil layer of 15-cm, it can be of more importance to know SOC values in a thicker layer to assess the relative importance of soil management on SOC in the soil, since soil fertility and access to nutrients in the deeper soil layers should have also an outcome on olive production. Determination of soil stock of organic carbon for other purposes, such as for instance carbon sequestration, should also consider a thicker layer.

Calculations of TOC (0-100 cm) resulted in an average of 57.3 t/ha in Matasanos, 26.8 t/ha in La Teja, and 33.0 t/ha in Nicolás (appendix 7). SOC stock in both orchards (Matasanos and La Teja) were relatively unaffected if the differences in SOC in the top soil (0-15 cm) between lane and canopy area were not considered, given the relatively small differences concentrated only in the top 15 cm of the soil. For Matasanos the difference is 57.6 vs. 57.3 t/ha (0.4%) and 26.2 vs. 26.8 t/ha in La Teja (2.3%). For Nicolás this was 5.1%, which is a more significant percentage.

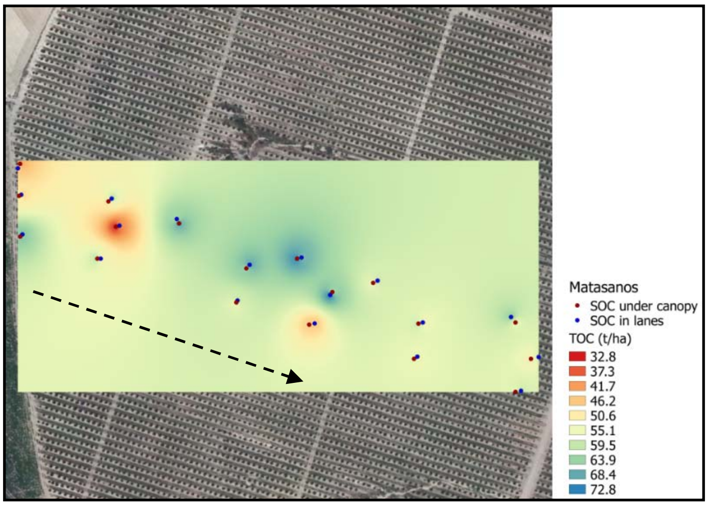

Figure 9: Distribution of Total Organic Carbon contents, Matasanos.

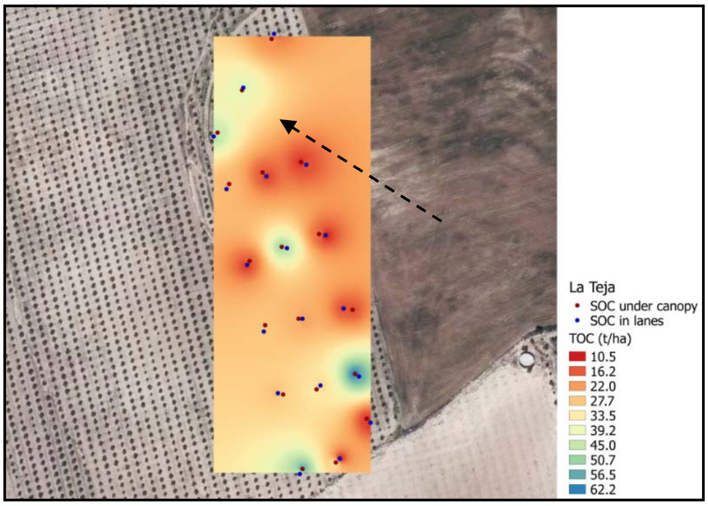

Figure 10: Distribution of Total Organic Carbon contents, La Teja.

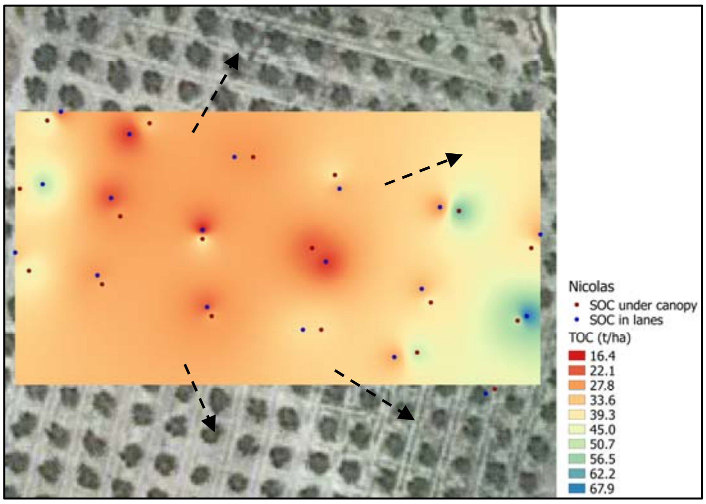

Figure 11: Distribution of Total Organic Carbon, Nicolás.

Total amount of SOC in Matasanos shows a large range from 33 to 72 t/ha per sampling point, Fig. 9. Soil sampling spots with highest TOC values are concentrated in the centre of the slope. The upper part shows more spots with low TOC amounts. This is also the case in the area down the slope.

La Teja has predominantly low TOC values which are between 10.5 to 30 t/ha. Some outliers are present, but these are spread over the field resulting in a large range. Overall, lowest TOC values are found halfway the study area, Fig. 10.

TOC variability in Nicolás, Fig. 11, shows the opposite of Matasanos. Lower TOC values can be found in the middle of the slope, while higher concentrations are found on the top of the hill and down the slope.

3.2 Analysis of topographical factors on SOC and TOC variability

3.2.1 Analysis of topographical factors on SOC variability, Matasanos

Matasanos, Fig. 12, shows a clear pattern of erosion areas and an alluvial fan down the slope. Remarkable are the sharp boundaries of simulated erosion and deposition areas with high quantities. The model calculated a total soil erosion amount of 44 t/ha/yr., and deposition within the catchment was simulated to be 43 t/ha/yr., resulting in a net loss of 1 t/ha/yr. A gully seems to be the cause of the high erosion amount, but the alluvial fan ends within the field, resulting in a low amount of sediment leaving the field.

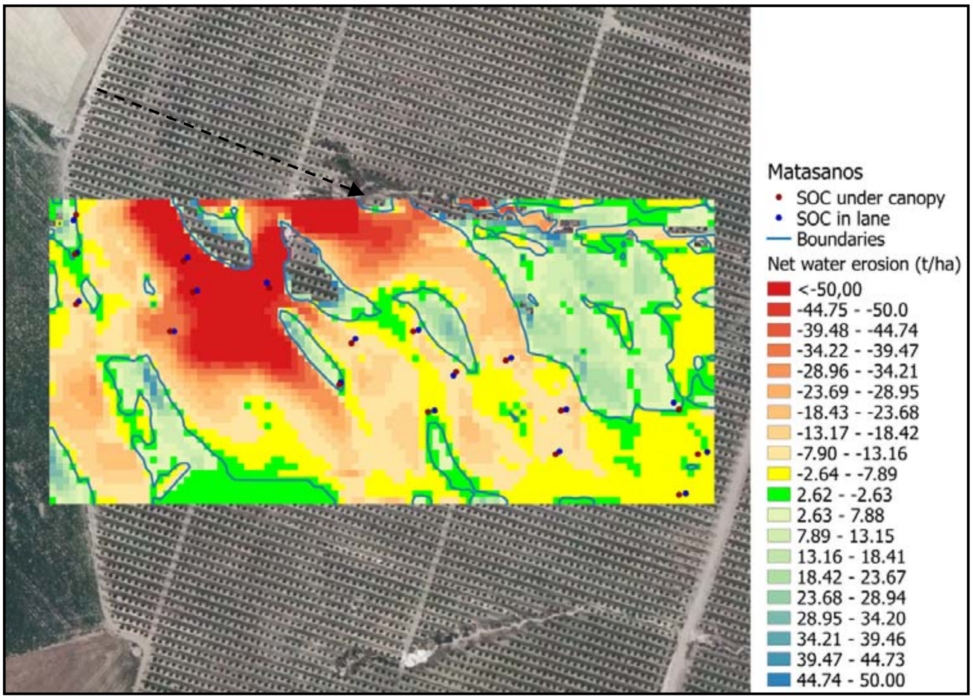

Figure 12: Water erosion and deposition map, Matasanos. A large erosion area is located within the study site, while the depositional area of the gully is located next to the study area.

Comparing the erosion and deposition patterns within the sampling areas with the SOC concentration in the first 15-cm soil layer (Fig. 6), a slight trend is apparent. Areas with low erosion rates or deposition in the down side of the study area show the highest SOC values. On the other hand, there is not a direct link of high erosion rates and low SOC values.

A link between TOC stocks (Fig. 9) and erosion pattern is not clearly visible. Some sampling spots with high TOC are located in the neighbourhood of deposition areas; however, some eroding areas also show relatively high TOC values.

Box-plots are created to explore possible trends between SOC concentration distribution and topographical factors: erosion/deposition, slope angle and surface altitude.

Regarding SOC concentration and deposition classes within the lanes, no trend is visible of any increase or decrease. No sampling points were located in depositional areas of more than 5 t/ha

(Fig. 13a). Fig. 13b shows no trend either, though the range of SOC concentration is less diverse than in the lanes. Again no sampling points were located in depositional areas. In the comparison between SOC and slope angle, no trend is visible within the lanes (Fig. 13c). Under tree canopy a negative trend of SOC is visible when slope angle class increases (Fig. 13d). In fig. 13e, the distribution of SOC concentration in the lane along the surface altitude shows no pattern of increasing or decreasing values. In the areas under tree canopy, an increasing clear trend appears when surface altitude decreases (Fig. 13f).

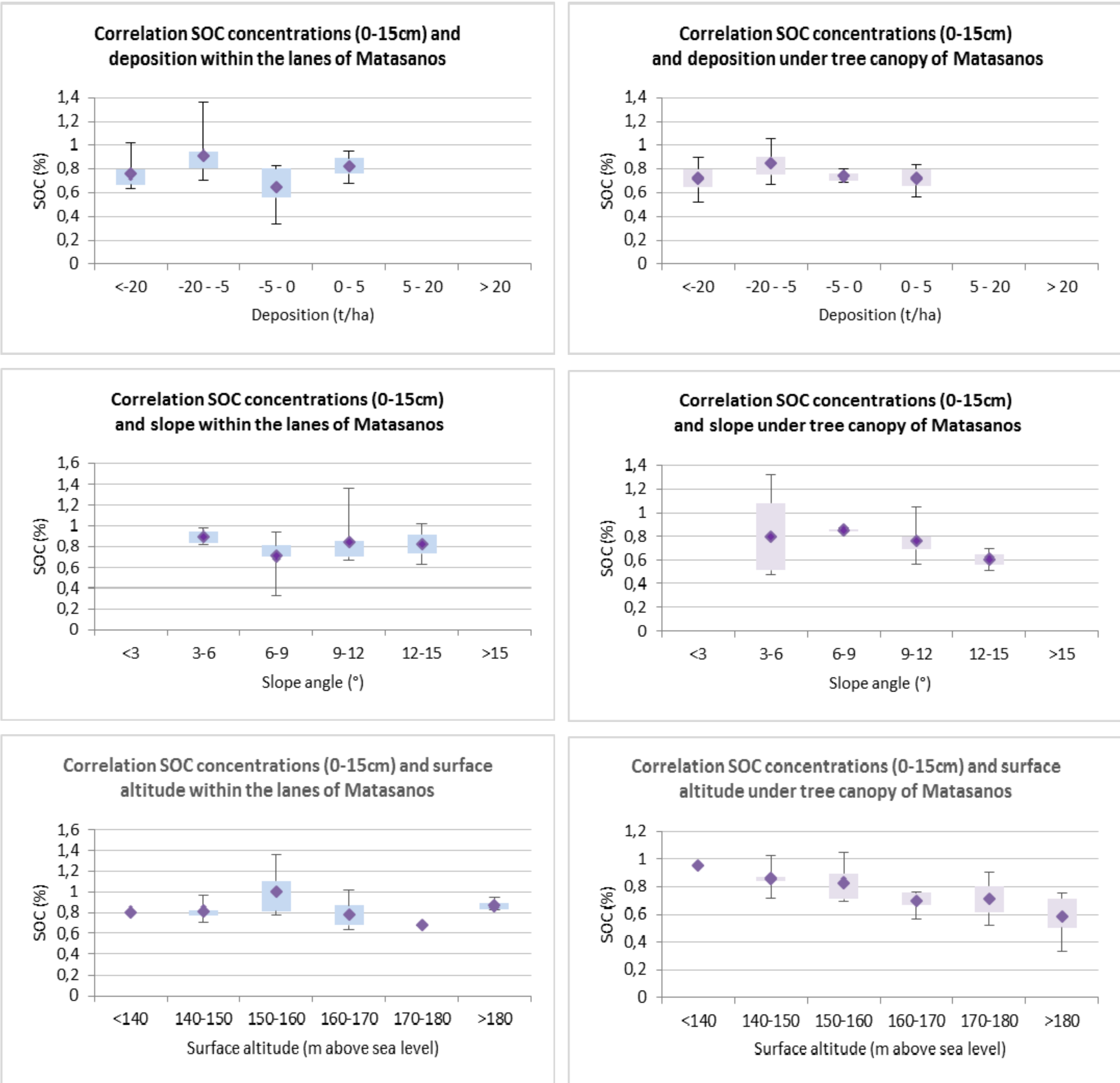

Figure 13: Comparison of top soil layer (0-15cm) with deposition rates, slope angles and surface altitude in Matasanos. a) SOC vs. deposition within the lanes, b) SOC vs. deposition under canopy, c) SOC vs. slope angle within the lanes, d) SOC vs. slope angle under canopy, e) SOC vs. surface altitude within the lanes, f) SOC vs. surface altitude under canopy.

When comparing TOC with deposition rates, it is apparent that TOC is not evenly distributed over the erosion classes within the lanes and under canopy; and no trends exist (Fig 14a&b). TOC contents appear to be lower in deposition classes -5-0 and 0-5 t/ha. These two classes also show small ranges in TOC contents compared to the other two classes, which partly can be explained by the low number of sampling points (3 for each class). The comparison between TOC and slope angle within the lanes does not show a trend (Fig. 14c), while a slight increase in TOC contents is visible when slope angle increases in the areas under the canopy (Fig. 14d). Although, a remarkable incident is visible; a sharp decrease occurs in transition to the slope angle class of 12-15°. Fig. 14e shows a slight increase in TOC content as the surface altitude decreases. Within the surface altitude classes variability is clearly evident. The distribution of TOC content under tree canopy (Fig. 14f) is even larger than in the lanes, but no trend does exist.

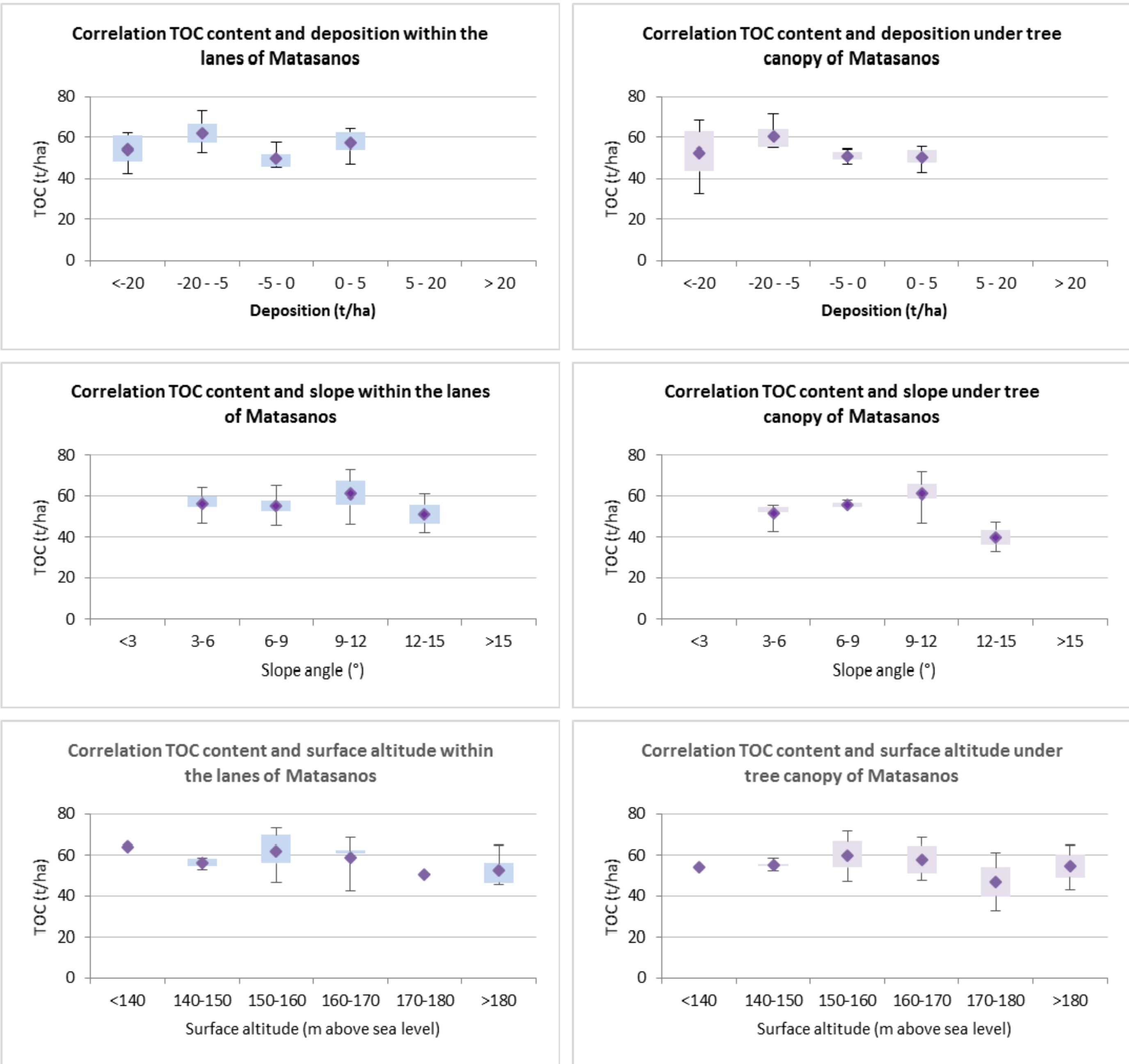

Figure 14: Comparison of total soil organic carbon with deposition rates, slope angles and surface altitude in Matasanos. a) TOC vs. deposition within the lanes, b) TOC vs. deposition under canopy, c) TOC vs. slope angle within the lanes, d) TOC vs. slope angle under canopy, e) TOC vs. surface altitude within the lanes, f) TOC vs. surface altitude under canopy.

3.2.2 *ANALYSIS OF TOPOGRAPHICAL COMPONENTS ON SOC VARIABILITY, LA TEJA*

La Teja, Fig. 15, shows a mosaic of erosion and deposition areas. The total sediment production, as calculated by Watem/Sedem, was 1055 t/ha/yr., but 853 t/ha/yr. was deposited within the study area, resulting in 202 t/ha/yr. of net soil loss. This is an extremely high value, and it could be explained by the long and steep slope, and the active gully which leaves the study area directing to the north. Again a clear boundary between erosion and deposition areas is present.

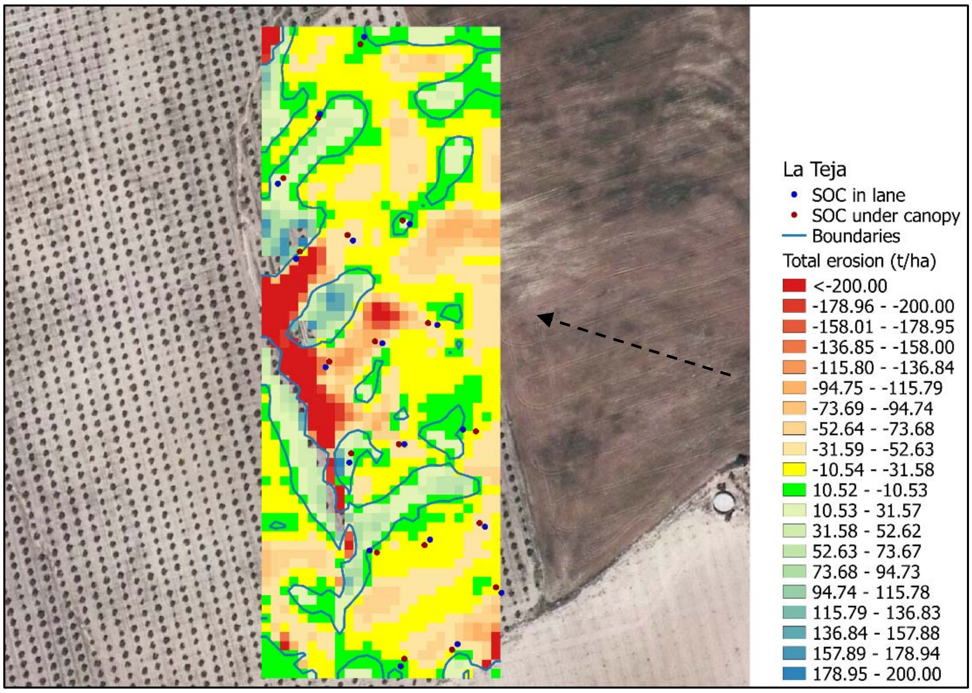

Figure 15: Net erosion and deposition map of La Teja.

Erosion and deposition patterns do not show an equal pattern with SOC values in the first 15-cm of the soil, Fig. 7. There is no trend of low SOC in erosional areas and high SOC values in depositional areas, although this is valid for some locations such as the north-western part of the study area. High SOC and TOC values are located there, which coincides with soil deposition, Fig. 10.

Looking at fig. 16a&b, most sampling points are located in erosion areas and variability within the erosional classes is limited, but no patterns were found. All sampling points are located on slopes between 3° and 15°, fig. 16c&d. Variability within each slope angle class is high. Only a moderate decrease in SOC concentration is recognisable when slope angle increases. In sampling areas under tree canopy there are a clear trend; SOC concentrations in the top 15-cm of the soil decrease when slope angle increases. The surface altitude does not have any impact on SOC concentration in the top 15-cm of the soil in the lanes and under canopy (Fig. 16e&f). The box-plots show a totally random distribution of SOC concentration over all classes.

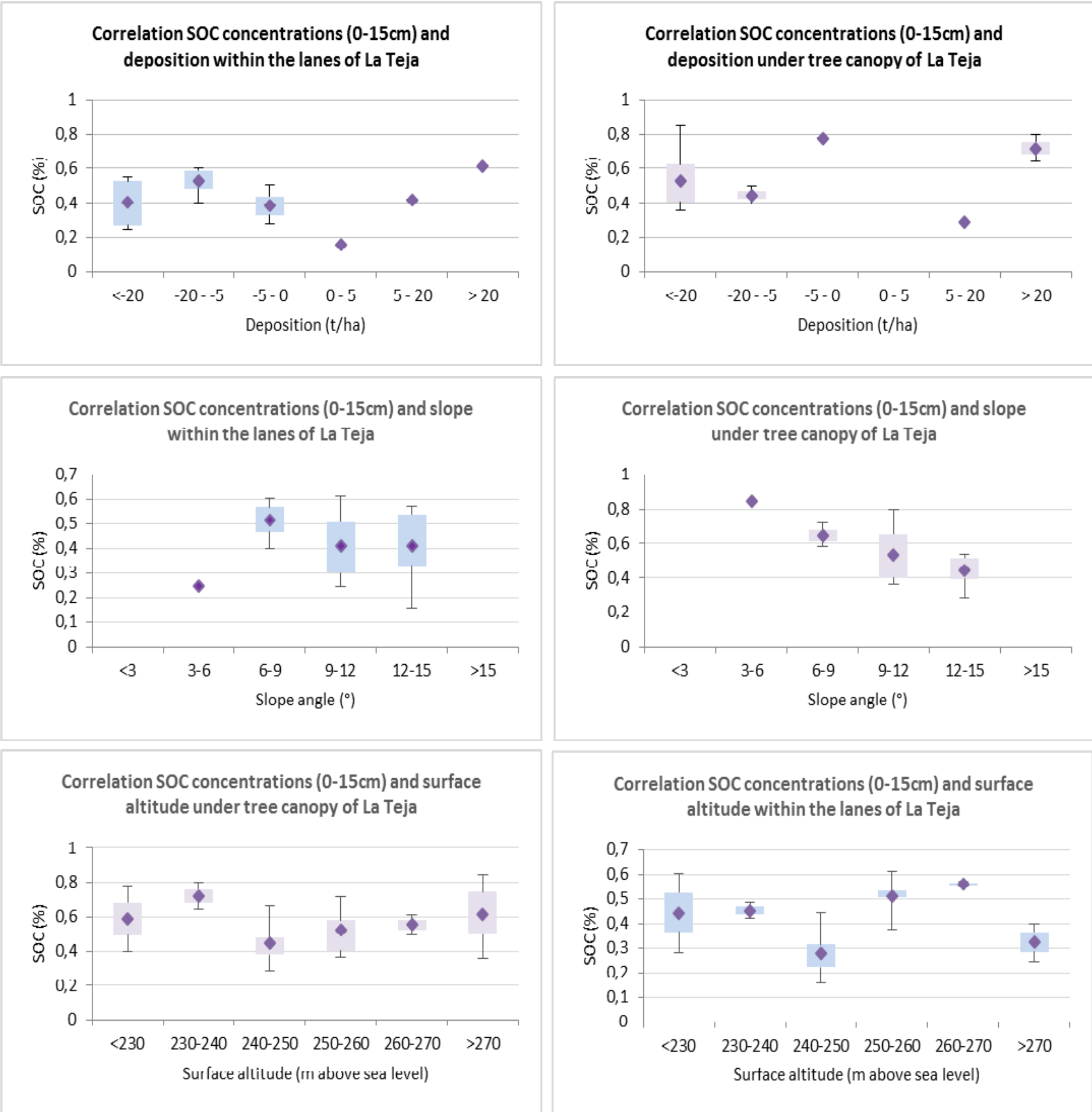

Figure 16: Comparison of top soil layer (0-15cm) with deposition rates, slope angles and surface altitude in La Teja. a) SOC vs. deposition within the lanes, b) SOC vs. deposition under canopy, c) SOC vs. slope angle within the lanes, d) SOC vs. slope angle under canopy, E) SOC vs. surface altitude within the lanes, F) SOC vs. surface altitude under canopy.

For TOC, again erosion and deposition patterns appear not to have a simple and direct correlation in both sampling areas (Fig. 17a&b). The distribution of sampling points with variable TOC content is fully random. More sampling points are located in erosion areas, but the TOC variabiability within these classes is high. Fig. 17c has a limited distribution of sampling points over all classes. In the classes of 6-9, 9-12 and 12-15° a slight decrease in TOC content is apparent, though the low TOC value within the slope angle class of 3-6° is not in line with this slight trend, it only weakens the trend. Fig. 17d visualises a trend of a decrease in TOC content when slope angle increases. In this case it is probable that TOC content is related to slope angle.

Surface altitude and TOC do not correlate to each other in the lanes (Fig. 17e). Fig. 17f does not represent any trend in this case. On the other hand, there is a clear resemblance with the box-plot of fig. 17e. A direct link is apparent in this situation.

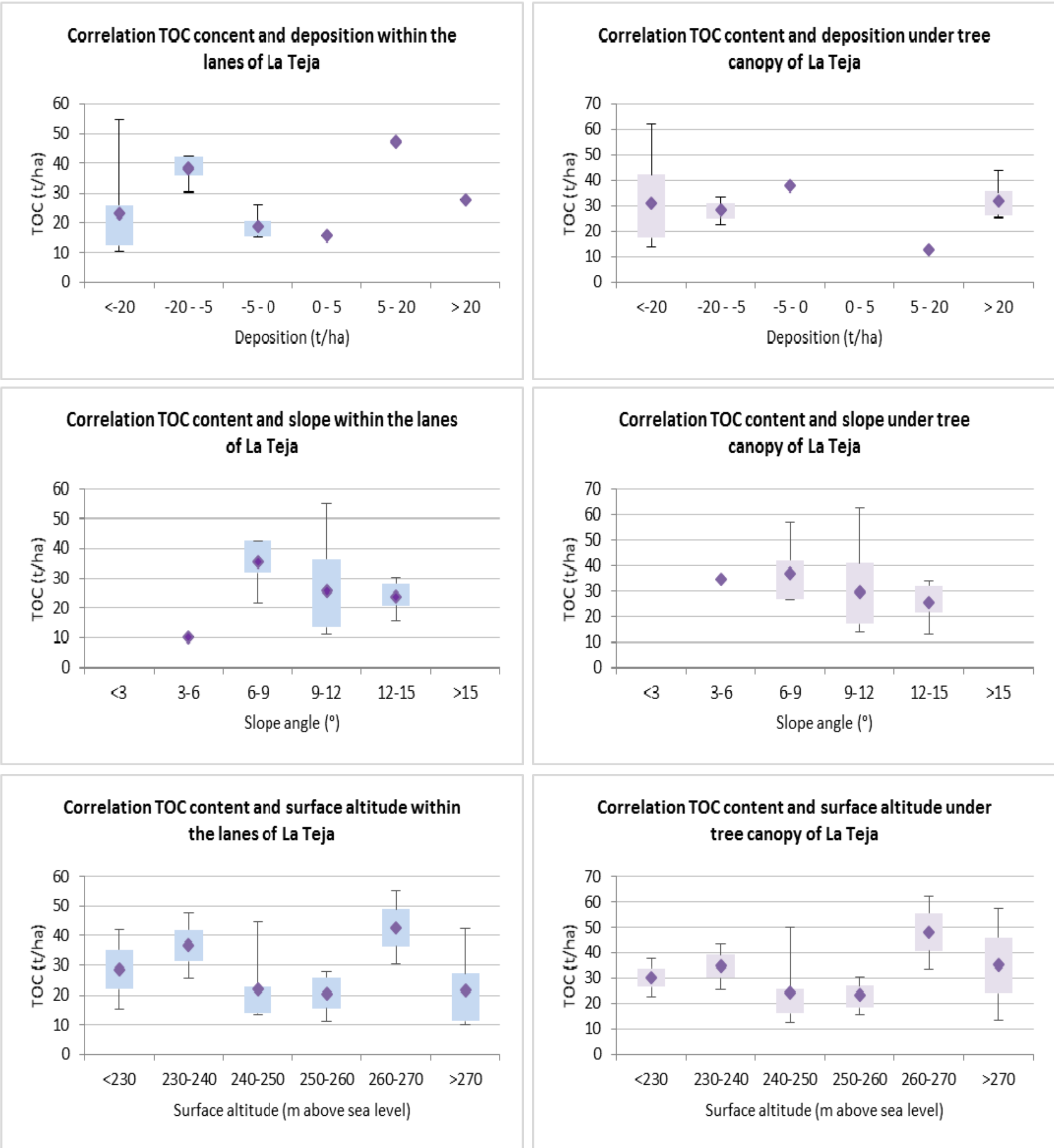

Figure 17: Comparison of total soil organic carbon with deposition rates, slope angles and surface altitude in La Teja. a) TOC vs. deposition within the lanes, b) TOC vs. deposition under canopy, c) TOC vs. slope angle within the lanes, d) TOC vs. slope angle under canopy, E) TOC vs. surface altitude within the lanes, F) TOC vs. surface altitude under canopy.

3.2.3 Statistical analysis of topographical components on SOC variability, Nicolás

The calibrated model for Nicolás resulted in a total sediment production of 265 t/ha/yr., of which 120t/ha/yr. was deposited within the study area, resulting in a total net sediment loss of 145 t/ha/yr. The depositional area is located down the slope on the eastern side, Fig. 18. Halfway the hill slope erosion rates are highest. On the plateau soil redistribution is limited.

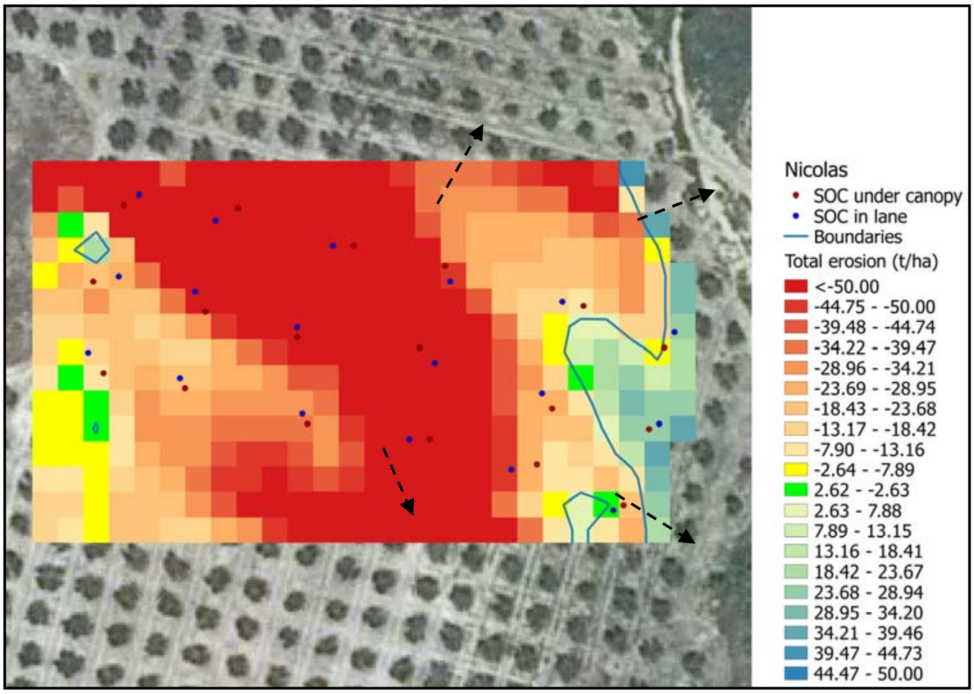

Figure 18: Net erosion and deposition map of Nicolás.

Nicolás shows a clearer correlation between erosion and deposition patterns and SOC, Fig. 8. High erosion rates go along with low SOC concentration and TOC content, while areas with low erosion rates or high deposition rates have higher SOC or TOC values, Fig. 8&11. These areas are located on the top of the hill slope, the plateau, and down the slope. Remarkable is the divergence of high SOC (0-15 cm) values on the top of the hill combined with low TOC (0-100 cm) values, and high TOC values in the downhill part of the slope with low SOC values.

The vast majority of sampling points are located in the erosion areas, fig. 19a. The variability within the two classes (<-20&-20--5t/ha) is high, resulting in no recognisable trend between erosion and deposition patterns to SOC concentration in the top 15-cm of the soil within the lanes. Fig. 19b shows the same structure as fig. 25a. Striking is that SOC concentration in the depositional areas are lower than in the erosion areas. Fig. 19c&d show a trend of gradual decrease of SOC concentration when slope angle increases. On the other hand, this trend stops in this case for slopes greater than 12° under canopy (Fig. 19d). Regarding surface altitude, downslope located sampling points show higher SOC concentration while this is also the case for the plateau on the top of the hill slope. The intermediate area contains sampling points with lowest SOC concentrations (Fig. 19e). Beside one split class (225-230m above sea level) a trend of higher SOC concentrations at higher located sampling points is clear under canopy (Fig. 19f). This is not in line with fig. 19e.

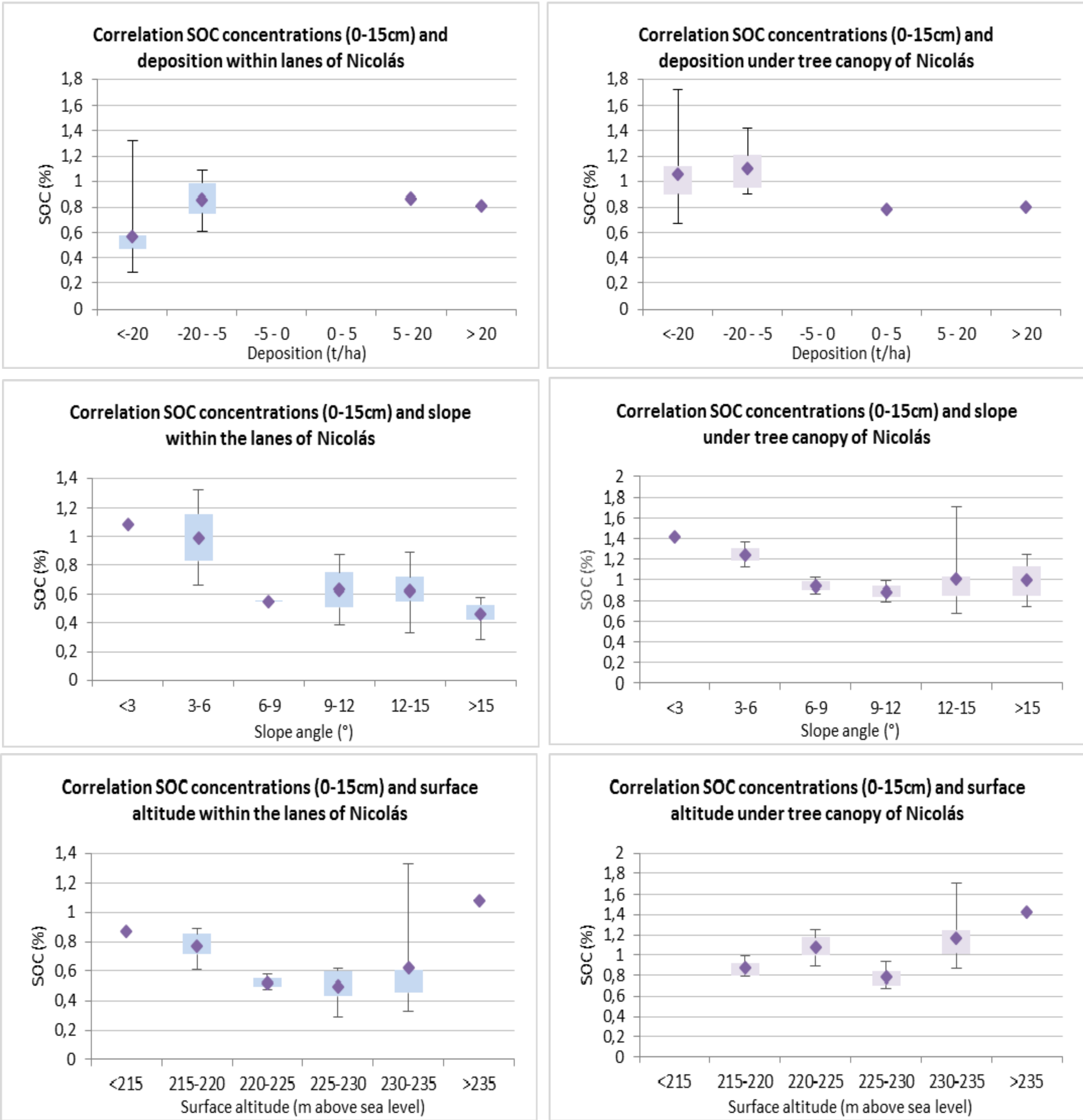

Figure 19: Comparison of top soil layer (0-15cm) with deposition rates, slope angles and surface altitude in Nicolás. a) SOC vs. deposition within the lanes, b) SOC vs. deposition under canopy, c) SOC vs. slope angle within the lanes, d) SOC vs. slope angle under canopy, e) SOC vs. surface altitude within the lanes, f) SOC vs. surface altitude under canopy.

Fig. 20a shows that the sampling spots are mostly concentrated within erosional areas. These two classes show an increase of TOC content when erosion rate decreases, although this trend cannot be verified by other classes. Fig. 20b gives similar results as fig. 20a. Fig. 20c does not represent a tendency of decreasing TOC content when slope angle increases; it is stable around 30t/ha. This is mainly due to the box-plot in slope angle class of 12-15; most sampling points are located in this range. Fig 20d has similarities with the pattern of TOC within the lanes. However, an unclear jump is recognisable from slope angle class of 6-9° to 9-12°. Although on both sides of the jump a stagnating trend of TOC content is recognisable. The surface altitude class of 215-220 m above sea level, Fig. 20e, deviates from the balanced pattern. Although it is based on three TOC values, its position is remarkably higher. Fig. 20f shows a rising and falling trend. The falling trend could indicate that TOC increases when surface altitude is lower. The rise in TOC content could be explained by the presence of the plateau on top of the hill slope.

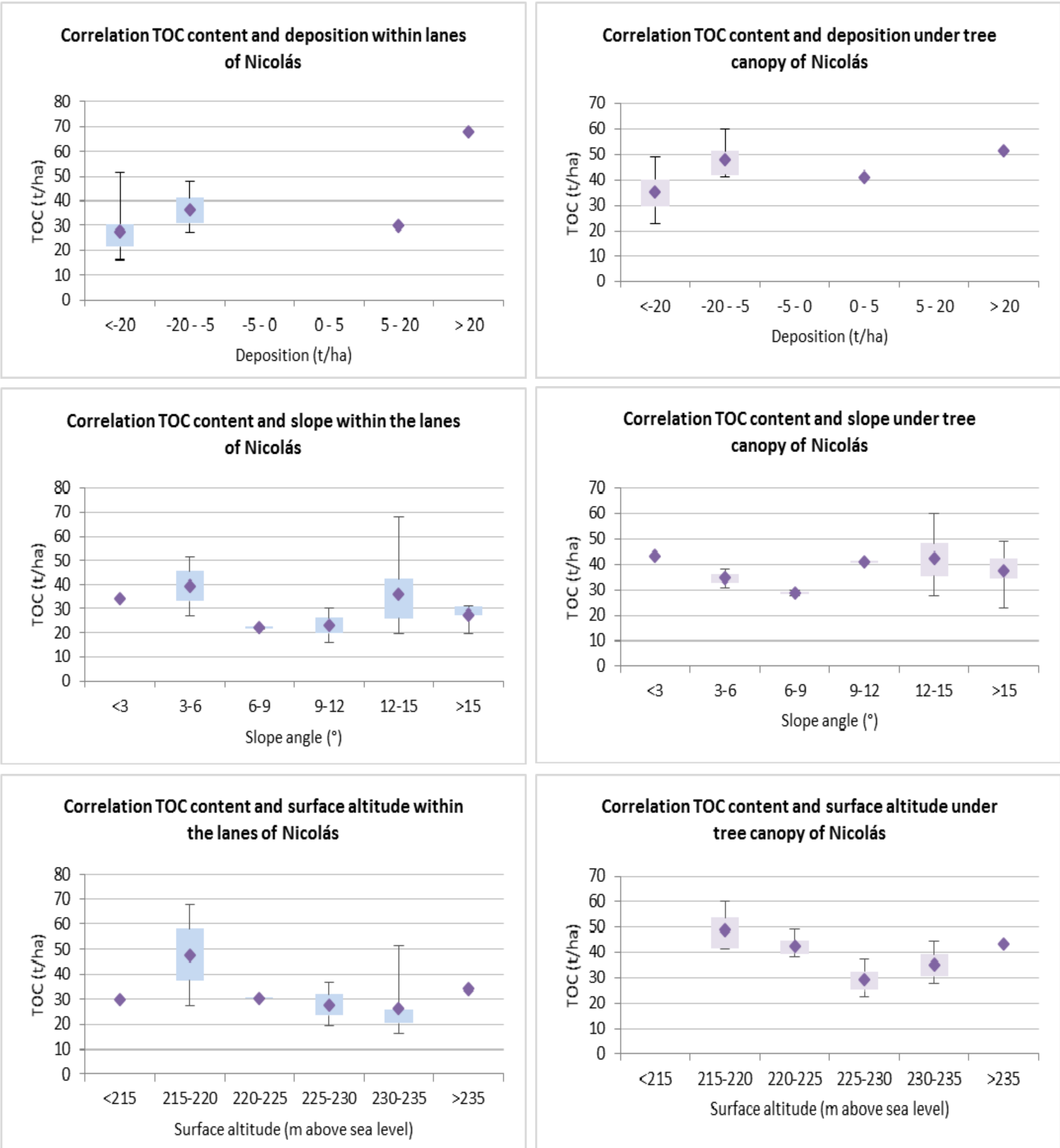

Figure 20: Comparison of total soil organic carbon with deposition rates, slope angles and surface altitude in Nicolás. a) TOC vs. deposition within the lanes, b) TOC vs. deposition under canopy, c) TOC vs. slope angle within the lanes, d) TOC vs. slope angle under canopy, E) TOC vs. surface altitude within the lanes, F) TOC vs. surface altitude under canopy.

3.3 ANALYSIS OF VARIANCE

ANOVA was applied to determine significant differences in SOC and TOC for the different independent variables or factors: farm (Matasanos, La Teja and Nicolás), sampling area (in lanes and under canopy), slope steepness (>30% and <30%), erosion or deposition area and erosion rate (<20 and >20 t/ha), Table 3.

Table 3: Results of ANOVA. Green boxes indicate a significant difference in the dependent variable for the corresponding independent variable or factor. Red indicates that there is no significant difference.

Significant difference in variation (*P*<0.5)	Dependent variable				
Independent variable	SOC 0-15 cm	SOC 15-30 cm	SOC 30-60 cm	SOC 60-100 cm	TOC
Farm	Green	Red	Green	Green	Green
Sampling area	Green	Green	Red	Red	Red
Slope steepness	Red	Red	Red	Red	Red
Erosion/Deposition	Red	Red	Green	Red	Red
Erosion rate	Green	Green	Red	Green	Green
Farm×Slope	Red	Red	Red	Green	Green
Farm×sampling area×Slope	Green	Red	Red	Red	Green
Farm×Slope×Erosion/Deposition	Green	Red	Red	Red	Red
Other interactions	Red	Red	Red	Red	Red

SOC 0-15 cm

Farm, sampling area and erosion rate were significant factors in this soil layer. The interactions farm×sampling-area×slope-steepness and farm×slope-steepness×erosion/deposition also were significant factors. Slope steepness and erosion/deposition appeared not to have a significant link with SOC distribution in the top soil layer. Farm had largest share in total variation (partial sum of squares), meaning that this independent variable is the major contributor of SOC variance.

SOC 15-30 cm

No significant difference in SOC were observed between farms in this soil layer. On the other hand, a significant different in SOC concentration were observed between sampling areas (line vs. under canopy). This also applies to erosion rate factor (<20 vs. >20 t/ha). The amount of variance in slope gradient and erosion/deposition were not significantly different in this soil layer. Other interactions of independent variables do not result in a significant correlation.

SOC 30-60 cm

Significance difference in SOC concentration was only observed between farms and erosion/deposition areas in this soil layer. A strong interaction in SOC variance and erosion/deposition patterns in this soil layer seems unlikely. Probably this happened by chance. In this soil layer, a correlation in SOC variability and sampling areas has disappeared. SOC differences for the other independent variables or interactions appear not to be significantly different.

SOC 60-100 cm

Significant difference in SOC concentration between the different farms was observed in this soil layer. A significant difference also appeared for erosion rate factor (<20 vs. >20 t/ha), but this seems to be an unlikely causal relationship as this significant correlation was absent in an upper soil layer. An interaction of farm×slope exists; once again this seems to be by chance.

TOC

The ANOVA showed a significant difference in TOC between farms. Erosion rate also had a significant correlation with TOC. Further, farm×slope-steepness and farm×sampling-area×slope-steepness interactions showed a significant correlation with the TOC variances. Other independent variables or interactions showed no significant difference for TOC variation.

Overall, this analysis shows a strong connection between SOC variances and different farms (or study areas). This represents the effects of the different current soil management practices and orchard management history and differences in soils. A distinction between these three factors could not be made. Further, SOC variances between sampling areas in the first two layers are of importance. It affects SOC concentration in such a way that a distinction should be made, especially in relation to soil quality issues. In deeper soil layers, no effect is recognised. Effects of soil management practices (tillage, cover crop...) and potential biomass production by trees can be traced to the first 30-cm. Slope steepness (>30% vs. <30%)appears not to have any impact on SOC distribution, which corresponds with Gómez et al. (2009b), stating that tree characteristics and slope steepness were no soil properties responding to soil management system. Erosion or deposition, which was expected to be important determinants of SOC distribution, did not show any correlation. Probably some shortcomings of the model could be causing this. However, the separation of erosion rates at 20 t/ha appears to have a significant influence on SOC variance in the first two soil layers and TOC variance, which nevertheless makes clear that there is a link in erosion amounts and SOC distribution.

4. DISCUSSION

4.1 RESUME OF FINDINGS

This research to evaluate SOC variability by the influence of topographical factors in olive orchards under different soil management practices along complete hillslopes has provided insight into SOC variability and its interaction with management.

'Matasanos' had lowest SOC variability of all study areas and SOC concentration was evenly distributed. The impact of topographical factors on SOC variability appears to be limited. The only trend regarding SOC distribution was found in slope angle, but only in the sampling area under tree canopy. Most probable explanation for this is that only water erosion may occur under the tree canopy where soil is maintained bare and water converges and flows down easily, despite protection against the kinetic impact of rain drops by the tree canopy. As a result, runoff carries SOC away, enhanced by a steeper slope angles. An important issue is the similar vertical SOC concentration and distribution between the sampling areas. The presence of cover crop could explain this equal distribution between the lanes and under tree canopy; management induces a large biomass production by cover crops in the lanes and the removal of herbs under the tree canopy area. The areas with deeper roots (under canopy) were expected to have higher SOC concentration, but this is hardly the case. SOC concentration decreased gradually with increasing soil depth in both sampling areas. Other non-topographical causes of SOC variability were not found. According to the land owners the spatial variation in yield over the grove are almost equal.

"La Teja" had lowest SOC values compared to the other two farms (Matasanos and Nicolás). SOC concentration under tree canopy in the first 15-cm of the soil was significantly higher than that in the lanes. This can be explained by the ability of trees to produce biomass combined with higher erosion rates in the lanes. Leaf fall and root growth provide SOM into the soil, while a bare soil could lead to an easier mineralisation of SOM resulting in lower SOM concentration (Rhoades, 1997). Further, the tree canopy can protect the soil and organic carbon to run off during rainfall events. Box-plots show a random distribution of TOC content for all assessed topographical factors, except for slope angle under tree canopy where a negative correlation exists with SOC values in the top 15-cm; TOC decreased with increasing slope angle class. SOC and TOC within the lanes appeared not to have any correlation with topographical factors. Other reasons for SOC variability could not be given by the land owner. The tillage and bare soil seem to have a negative effect on SOC in the soil; these conditions increase the chance of mineralisation and runoff of SOC.

"Nicolás" was the olive orchard with more variable SOC concentration. Nicolás, the orchard with sparse natural vegetative cover which is removed in late winter by herbicide application, showed a more coherent structure of SOC, TOC and topographical factors. Statistically, classes of small slope angles had significantly higher SOC concentration in both sampling areas. The only connection which exists is surface altitude in the case of TOC under canopy with the plateau on the top of the hill and the lowest part of the slope having higher TOC content. Highest SOC values were found on the plateau on the top of the hillslope. Highest erosion amount was found halfway the hill, coinciding with low SOC and TOC values. Other than 'Matasanos' and 'Nicolás', SOC concentration varied significantly between sampling areas (lanes and under tree canopy) in the first 30-cm of the soil, with higher concentration in the soil under tree canopy. As in La Teja, the higher SOC concentration under tree canopy can be explained by the production of biomass by falling leaves and root growth. Besides, the tree canopy seems to protect the underlying soil for erosion as evidenced by small earth mounds under the trees, while in the lanes soil has been eroded, affecting SOC concentration.

4.2 MUTUAL COMPARISON OLIVE ORCHARDS

The significant difference between SOC values in the soil under canopy and in lanes in the first 30-cm in Nicolás and first 15-cm in La Teja could be explained by interactions between trees and soil. Olive trees affect the soil system by an increasing input of biomass to the soil, changing the morphological and chemical soil conditions (Rhoades, 1997). The chemical and physical nature of leaf, bark, branch and roots alter decomposition and nutrient availability via controls on soil water and soil fauna involved in litter breakdown. Root system scavenges soil nutrients and redistributes them beneath tree canopies, resulting in accumulations of nutrients. However, in this research SOC concentration only significantly differ in the top soil layers. Deeper soil layers appear not to benefit of this mechanism.

ANOVA showed that SOC in three of four soil layers and TOC significantly differ among the study areas (farms). This difference could be related to the different current management practices, orchard history and, to some extent, to the differences in soil types. When looking to the other factors, sampling area has a significant impact on SOC distribution. In the top 30-cm of the soil ANOVA showed significant variances in SOC values, indicating the influence of soil management practices. This significant difference was not found in deeper layers, though an impact of tree roots on SOC was expected.

A research by Agnelli et al. (2014) to SOC stocks in a vineyard in Italy found the same responses regarding soil management practices and SOC stocks; parts of the vineyard occupied by grass cover did have higher SOC stocks in the top 50-cm of the soil compared to harrowed areas. This points out to the accumulation of carbon by grass cover and the reduction of carbon storage by cultivation. Other than our research is an increase of SOC stock in the deeper soil found in the vineyard compared to the control study site where no vines were planted. This increase in SOC stocks is explained by the effect of vine root turnover in the soil. This phenomenon was not revealed in our research. In the deeper soils, SOC concentration gradually decreased and no distinction was found between SOC concentration in soil under tree canopy and soil in the lanes.

Erosion rate affected SOC concentration in the top 30-cm of the soil and TOC. This indicates that variances in SOC and TOC could be linked to the differences in management practices (Álvarez et al., 2007; Muñoz-Rojas et al., 2012; Soriano et al., 2012). Despite the visible trends of slope angle to SOC concentration in Nicolás (fig. 19c&d) and La Teja (Fig 16d), no direct correlation was found when looking at the variances. It should be taken into account that in ANOVA only the difference was tested between slope smaller and larger than 30%.

4.3 IMPLICATIONS FOR VALIDATION OF SOC OR TOC

Management practices proved to have a significant impact on SOC variability. Important is the length of time the management practices are applied. Soil samples in all olive orchards were taken in spring 2015 and the age of olive orchards differs: Matasanos (2007), La Teja (2005) and Nicolás (2000). In all three areas the same cropping system was applied prior to the change into an olive orchard: alternately cereals and sunflower. The differences in the age of plantations could affect the possibility to correctly assess the impact of similar soil management practices on SOC; in addition, differences in soil properties complicate the validation of the impact of management practices. Concerning this, assessing the rate of impact by topographical factors on SOC variability was impossible. The only valid possibility to assess the level of impact of a topographical factor on SOC is carrying out the same research in one olive orchard (same soil and the same date of plantation), but with multiple soil management practices. This research also implies the distinction of impact by soil management and soil type. Studies to SOC concentration in soils proved the importance of soil type on SOC sequestration (Muñoz-Rojas et al., 2012). Though this research focused on Vertisols, particle size distribution differs among the study sites resulting in different soil properties, affecting the dynamics with SOC. Summarizing, still some variability exists, complicating a reliable determination of the impact of topography on SOC distribution: in sampling design and also in the significance of evaluations with a limited number of samples.

4.4 Comparison TOC to other agricultural systems

Studies concerning soil type and land use regarding SOC variability are scarce, particularly for Spain. Muñoz-Rojas et al. (2012) investigated organic carbon stocks in Mediterranean soil types under different land uses in Andalusia, where soil and land use serve as determinants of the ability of soils to store C along Mediterranean systems. This research, based on information from digital databases, investigated relations between SOC and the following variables: mean annual precipitation, mean winter and mean summer temperature, elevation and slope. This regional scale research among several soil types found that Vertisols have generally high SOC content, explained by its high clay content and high moisture storage capacity. Estimations of TOC content for different agricultural systems were calculated. Main outcomes for Vertisols were: arable land 69.4 t/ha, permanent crops 58.6 t/ha, heterogeneous agricultural areas 74.6 t/ha, forest 98.7 t/ha, and scrub or herbaceous vegetation 27.7 ton/ha, based on soil profiles of 75-cm (Muñoz-Rojas et al., 2012). Differences between soil types are linked to land use and precipitation. Further, Vertisols appeared to have more vertical distribution of SOC in soil compared to other soils, indicating more interaction with deeper soil layers. This could partly explain the gradual decrease of SOC concentration with increasing depth in all study areas. This study also emphasizes the influence of precipitation and temperature; climate is the main factor for biomass production, supported by soil fertility, photosynthetic efficiency and fertilisation.

Estimations of Díaz-Hernández et al. (2003) determined TOC content of 70 t/ha for 1-m soil, in the case of a Calcisols, which just as Vertisols has generally high SOC values. For Vertisols, in Spain, Rodríguez-Murillo (2001) reported 68.9 t/ha TOC in field crops. In Jordan, Batjes (2006) reported 75 t/ha at 1-m depth. In Tunesia, Brahim et al. (2010) estimated 109.7 t/ha at 1-m depth. Batjes (2002) found values of 236 t/ha TOC at 1-m depth in Central and Eastern Europe.

TOC in the olive orchards of our study are in the lower range of the outcomes of these investigations. Though, some assumptions were made for the calculations, outcomes appear to be more probable than in the studies mentioned above which are made by model calculations based on standardized values.

4.5 Erosion within olive orchards versus model predictions

The particular olive orchard structure consisting of lanes and tree rows and soil management determine SOC distribution and erosion processes. Despite model predictions and statistics which imply that erosion is not correlated to SOC distribution, erosion patterns were visibly affected by the structure of the orchards. Watem/Sedem is not designed to model gully erosion, but only small rill and sheet erosion on long term. Soil management can be processed in RUSLE by soil erodibility factor and crop management factor, while the orchard design cannot be represented by a single factor. This may explain the limited correlation between erosion patterns and SOC distribution modelled by Watem/Sedem.

Field observations gave the following results, which were not well predicted by Watem/Sedem. Each orchard had its own visible (gully and sheet) erosion patterns which are not well predicted by Watem/Sedem. The common directions of tree rows along the slopes affect the erosion patterns and soil management (cover crop direction or tillage direction). Examples are the mounds under the trees in Nicolás; directly, tree canopy protects the soil under the tree to splash erosion, but indirectly runoff converges on lanes, which strengthens splash erosion. The orchard design (a square frame) makes it possible for runoff to flow into all directions. Matasanos showed a totally different erosion pattern. Due to the cover crop, erosion was not visible in the lanes, while small gullies were originated along the border of cover crop, located in the bare soil area under tree canopy. Since the tree rows form a hedgerow along the slope and cover crop strips are strait, the gullies also only directed longitudinally to the slope direction. This resulted in small gullies on both sides of the tree rows. In La Teja tree rows direction did not entirely coincide with the slope direction. Due to the tillage, no effect of orchard structure on erosion patterns was visible; a small gully was generated according to slope direction. All olive orchards have shown their rate of impact of frame structure and tillage practices on erosion. These are the limitations of using Watem/Sedem.

4.6 Scale of research

The scale of research is important to serve the objective of this research to find the possibilities to certify olive orchards for sustainable management according to soil management and topography. This hill-slope scale research gave insight in the distribution of SOC in different soil layers under different topographical and soil management circumstances and enabled the relation and distinction between the two field conditions of soil: in lanes or under tree canopy. However, as already mentioned before, assessing the rate of impact of different soil management practices is complicated due to the involvement of the three olive orchards representing different soil management practices, but they also differ in age and soil properties. To assess this rate of impact of soil management, a small scale experiment should be carried out in one field (similar conditions) with different soil management practises. The same counts for the topographical factors influencing SOC distribution.

4.7 Certifying olive orchards

4.7.1 Implications for certifying/predicting SOC in orchards

A straightforward manner for certifying olive orchards for sustainable practices appears not to exist, many factors affect the rate of sustainability resulting in a high spatial variability. SOC sequestration is a key indicator of soil quality and agricultural sustainability (Reeves, 1997; Gómez et al., 2012), but other properties play an important role in soil fertility as well. Soil type, environmental circumstances, orchard features and management practices together form the conditions of a specific orchard. Topographical factors do have their particular role in these orchard conditions and, in that way, affect SOC distribution. This research has shown that effects of topographical factors are mainly related to management practices: differences between farms and locations within an olive orchard (under canopy or in the lanes). A high unexplained spatial variability exists that can be attributed to the combination of several sources: orchard design, topographical factors, length of time of soil management practices, history, erosion or traffic. The interaction among these factors raises the question about the extrapolation of the results of a "controlled" experiment such as the one suggested in section 4.6 even if this were feasible. Studies considering intense sampling and detailed models have been able to explain variability of SOC in field crops (e.g., Jague et al., 2016). However, studies in orchard fields, e.g. apple (Umali et al., 2012) or citrus (Wanshnong et al., 2013) indicate an even more complex pattern and limited differences across slope positions (e.g., Wanshnong et al. 20134). It is quite possible that there will always be a large, unexplained variability which overcomes most of the initial hypothesis about relatively straight correlations among spatial patterns of SOC and soil redistribution. Certification of sustainable practices can be supported by soil management practices and topographical factors, but cannot be fully based on these factors.

4.7.2 POTENTIAL FOR IMPROVEMENT UNDER MORE SUSTAINABLE MANAGEMENT

Climatic conditions

Next to topographical factors the study of Muñoz-Rojas et al. (2012) emphasizes the influence of precipitation and temperature; climate is the main factor for biomass production, supported by soil fertility, photosynthetic efficiency and fertilisation. This emphasises the influence of factors other than topographical factors, and so could complement the explanation of SOC variability. Regarding developing sustainable land management practices in olive orchards, water availability and temperature will be the limiting factors regarding SOC sequestration (Ganuza and Almendros, 2003; Muñoz-Rojas et al., 2012), with the consequence of limited options for more sustainable practices; cover crop management seems to be most feasible sustainable land management practice.

Soil and seasonality

As mentioned in Muñoz-Rojas et al. (2012), Vertisols do have a high potential for SOC sequestration. Their texture, mainly consisting of clay particles, can bind SOC easily compared to soils with coarser textures. By contrast, its properties result in difficult hydrological and erosive responses; its swelling character leads to low permeability in wet conditions, initiating runoff more easily and so results in less groundwater storage (Taguas et al., 2011; Gómez et al, 2014). As a result, the combination of occasionally heavy rain, soil and temperature implicate the range of possibilities for sustainable practices. The period for SOC sequestration is in autumn, winter and early spring. Due to the complicated property of swelling, the retention of water could be a point of interest for potential improvement of the hydrological systems and SOC sequestration. Thoughtful soil management practices are the solution for improved water retention.

Improving current sustainable practices

The significant negative correlation between SOC and elevation for Vertisols, found in this study and by Muñoz-Rojas et al. (2012), may indicate the importance of water retention in the upper areas of the hill slopes. Regarding erosion, cover crop management have shown its positive effect to prevent this phenomenon. For improving this management practice, the emphasis should nowadays be more concentrated on measures aimed at preventing gully erosion and vegetation buffers to block rill erosion as proposed in Gómez et al. (2014). Additional to this, other management practices for this issue are known and applied already: half-moon/bund-tips structures for retaining runoff. These can be applied in the lanes, where no cover crop is present or under canopy to prevent rill erosion along the cover crop which was present in Matasanos. The application of this measure could be difficult to a certain extent due to its highly intensive labour demand.

Regarding the potential of improvement of soil fertility, the choice of cover crop species is of importance. Biological Nitrogen fixation by growing leguminous species could be an option to improve soil quality. Water consumption of these species could be a critical issue; research to its applicability should be done. These species should grow during moderate temperatures (in winter), but should deactivate themselves or killed by herbicides (preferably not) when temperatures start to rise. When these are grown under tree canopy, soil properties can be improved and potential erosion can be prevented. In the study of Espinoza et al. (2011), an annual crop rotation was applied of leguminous species (*Lupinus angustifolium*, *Lupinus luteus*, *Pisum sativum*, *Vicia atropurpurea*) and wheat. The environmental circumstances were more or less equal (Mediterranean climate, rainfall 500-750 mm/yr., altitudes from 100-500 m above sea level on moderate or rolling hill slopes). Point of issue is the sensitivity for long dry spells, but this also indicates its positive applicability.

Another species which proved to have a positive effect on soil and water conservation is *Oxalis pes-caprae*. This species grows in winter, but is highly sensitive to drought, its wilting point is in late spring due to its shallow rooting depth and a lack of water in the upper soil layer, and in that way, will not compete for water and nutrient consumption. It grows well at semi-arid temperatures. Environmentally, this species is tolerant for annual rainfall between 500-1000 mm and can be applied on hill slopes with altitudes until 500 m above sea level. A negative effect of this species is its character of an invasive species (Kosmas, 2011).

Regarding sustainability of olive orchards, major progression is made already. Soil management practises such as applied in 'Matasanos' are a good step forward to sustainable agriculture in Andalusia. Only minor improvements could be made in future. Despite all attention put in creating a more sustainable way of olive farming, the harsh climate conditions will always be the limiting factor in pursuing sustainable land management in olive orchards.

5. Conclusion

This research is a continuation of previous research to the certification potential for carbon sequestration in olive orchards. SOC is a key indicator of soil quality and a major factor for evaluating carbon sequestration schemes in agricultural soils. SOC presents a large spatial variability at farm and catchment scale which complicates the evaluation of soil quality (Gómez et al., 2009b) and certification of the potential for carbon sequestration. This research had the objective to evaluate the possibility for the certification potential for carbon sequestration of olive orchards for sustainable management by exploring the impact of topographical factors on SOC distribution at hill-slope scale.

Orchard structure of olive grove explains a vast proportion of SOC variability. The division of tree rows and lanes resulted in significant differences in SOC concentration in the top 30-cm of the soil, depending on soil management practices in each orchard. Expected increasing SOC values in deeper soil layers located under tree canopy due to root remnants were not observed.

Another expectation was that agricultural activities and topography-driven erosion processes will contribute to SOC variability. Soil management practices strongly determine SOC concentration in the top soil and the variability of these concentrations over the hill-slope. Although a distinction was made between soil management practices and topographical factors, the interactions were strongly correlated to each other; topography plays a role when bare soil management is applied, but cover crop management proved to reduce the effect of topography on SOC distribution expressed in relatively equal distribution over the hills-lope and small variability.

Erosion and deposition patterns predicted by Watem/Sedem appeared not to explain SOC distribution, while it is plausible that erosion patterns will affect SOC distribution. Model limitations and the limited number of sampling points can be the reason that no relation was found between SOC distribution and erosion patterns. This suggests that the detection of this pattern is not straightforward without a dense sampling protocol.

A high unexplained spatial variability still exists that can be attributed to the combination of several sources such as orchard design, topographical factors, length of time of soil management practices, orchard history, erosion or orchard activities. This means that there will always be a large, unexplained variability. Certification of sustainable practices can be supported by soil management practices and topographical factors, but cannot be fully based on these factors.

Next to the objective to research the certification potential for carbon sequestration, this research underlined that new soil management practises strongly contribute to more sustainable olive cultivation. However, due to the harsh climatic circumstances in combination with non-optimal soil properties in southern Spain, real sustainable olive cultivation is difficult to achieve.

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APPENDICES

Appendix 1: Results SOC analysis

Matasanos

Soil sampling									
Date:	***06/03/2015***	***09/03/2015***							
Field:	***Matasanos***								
			With lid				With lid		
Spot/ location	Depth (cm)	**reference**	Total weigth	Dry weigth 35 °C	Weigth subm	Weigth subm 105°C	(g)	%C	%OM
Lane 1	0-15	M1	173.58	152.96			43.12	0.83	1.44
	15-30	M2	231.04	194.12			42.92	0.55	0.96
	30-60	M3	389.42	322.57			42.94	0.45	
	60-100	M4	534.56	468.12			43	0.24	0.41
Coordinates	30	*344251E*	*4183744N*						
Under tree 1	0-15	M5	153.56	140.42			42.99	0.75	1.30
	15-30	M6	265.79	227.07			42.69	0.56	0.97
	30-60	M7	391.98	332.99			42.79	0.42	0.72
	60-100	M8	525.02	470.76			42.75	0.21	0.36
Coordinates	30	344254E	41883744N	183m					
Lane 2	0-15	M9	178.27	155.97			43.19	1.01	1.75
	15-30	M10	218.17	184.67			42.99	0.48	0.83
	30-60	M11	451.07	375.61			44.26	0.50	0.86
	60-100	M12	628.68	530.33			43.16	0.41	0.71
Coordinates	30	344337E	4183712N	177m					
Under tree 2	0-15	M13	185.85	165.55			43.28	0.69	1.19
	15-30	M14	214.51	183.84			43.18	0.51	0.88
	30-60	M15	457.32	387.42			43.39	0.37	0.65
	60-100	M16	551.62	475.96			43.19	0.40	0.70
Coordinates	30	344336E	4183714N	169m					
Lane 3	0-15	M17	204.89	179.75	108.31	107.2	43.73	0.72	1.24
	15-30	M18	234.42	205.15	78.49	77.67	43.13	0.59	1.01
	30-60	M19	473.79	405.95	144.39	142.17	44.2	0.40	0.70
	60-100	M20	645.65	553.97	180.67	177.7	43.52	0.46	0.78
Coordinates	30	344399E	4183697N	165m					
Under tree 3	0-15	M21	170.28	156.46			42.97	0.76	1.31
	15-30	M22	247.12	219.13			43.16	0.89	1.54
	30-60	M23	509.84	446.07			43.1	0.59	1.02
	60-100	M24	595.62	522.13			43.24	0.39	0.68
Coordinates	30	344402E	4183700N	162m					

Lane 4	0-15	M25	280.94	241.58			42.58	0.86	1.48
	15-30	M26	182.85	158.72			42.82	0.58	0.99
	30-60	M27	472.53	403.89			42.66	0.55	0.94
	60-100	M28	626.17	533.07			44.27	0.44	0.75
Coordinates	30	344511E	4183656N	158m					
Under tree 4	0-15	M29	175.48	155.39			43.15	1.05	1.81
	15-30	M30	209.54	181.44			43.9	0.69	1.19
	30-60	M31	454.26	387.08			42.87	0.56	0.96
	60-100	M32	644.43	553.54			43.15	0.56	0.96
Coordinates	30	344511E	4183661N	152m					
Lane 5	0-15	M33	240.84	205.87			42.96	0.81	1.40
	15-30	M34	243.51	206.84			42.79	0.57	0.99
	30-60	M35	418.43	346.29			43.18	0.52	0.90
	60-100	M36	673.71	561.75			43.31	0.38	0.66
Coordinates	30	344581E	4183640N	151m					
Under tree 5	0-15	M37	156.95	139.99	96.95	96.03	44.19	0.87	1.49
	15-30	M38	247.75	214.12	123.11	120.89	44.08	0.51	0.89
	30-60	M39	449.49	386.32	111.65	109.71	43.18	0.43	0.75
	60-100	M40	552.36	490.16	136.25	133.54	43.02	0.43	0.74
Coordinates	30	344579E	4183637N	146m					
Lane 6	0-15	M41	215.61	183.55			43.84	0.95	1.64
	15-30	M42	222.08	189.33			43.17	0.68	1.17
	30-60	M43	491.29	409.38			43.16	0.55	0.95
	60-100	M44	631.31	541.86			42.59	0.37	0.64
Coordinates	30	344699E	4183603N	143m					
Under tree 6	0-15	M45	165.11	145.5			43.62	0.80	1.38
	15-30	M46	233.04	199.98			44.13	0.57	0.98
	30-60	M47	465.83	396.42			43.08	0.49	0.84
	60-100	M48	586.86	514.88			43.09	0.38	0.66
Coordinates	30	344707E	4183598N	144					
Lane 7	0-15	M49	186.85	165.73			43.42	0.33	0.57
	15-30	M50	230.19	200.61			43.03	0.56	0.97
	30-60	M51	439.03	372.56			41.98	0.48	0.82
	60-100	M52	554.85	488.06			42.71	0.32	0.55
Coordinates	30	344255E	4183714N	175m					
Under tree 7	0-15	M53	174.17	157.64			43.94	0.84	1.45
	15-30	M54	269.44	232.15			43.21	0.60	1.04
	30-60	M55	380.1	327.43			44.26	0.48	0.82
	60-100	M56	542.45	483.64			44.26	0.39	0.68
Coordinates	30	344252E	4183719N	180m					

Lane 8	0-15	M57	216.7	187.72			42.91	0.63	1.09
	15-30	M58	243.36	208.2			43.18	0.46	0.78
	30-60	M59	409.16	347.99			43.59	0.31	0.54
	60-100	M60	646.91	551.85			42.89	0.29	0.49
Coordinates	30	344344E	4183683N	170m					
Under tree 8	0-15	M61	175.53	161.49			42.62	0.52	0.89
	15-30	M62	264.28	230.31			42.68	0.31	0.53
	30-60	M63	393.06	339.95			42.91	0.33	0.57
	60-100	M64	445.62	397.43			43.16	0.23	0.39
Coordinates	30	344344E	4183688N	170m					
Lane 9	0-15	M65	206.25	182.37			44.27	0.86	1.49
	15-30	M66	283	248.44			44.24	0.67	1.15
	30-60	M67	421.98	363.74			44.34	0.62	1.06
	60-100	M68	600.47	533.73			44.35	0.36	0.62
Coordinates	30	344462E	4183652N	159m					
Under tree 9	0-15	M69	167.19	154.1			44.12	0.75	1.30
	15-30	M70	219.99	197.48			44.19	0.73	1.25
	30-60	M71	460.29	395.47			44.16	0.49	0.84
	60-100	M72	603.92	518.97			43.21	0.44	0.77
Coordinates	30	344459E	4183649N	159m					
Lane 10	0-15	M73	185.16	164.69	86.25	85.33	44.06	1.37	2.35
	15-30	M74	246.98	214.83	93.4	91.76	44.31	0.65	1.12
	30-60	M75	456.77	393.13	213.16	205.85	44.11	0.48	0.82
	60-100	M76	605.52	527.24	246.34	236.03	44.33	0.44	0.76
Coordinates	30	344539E	4183622N	154m					
Under tree 10	0-15	M77	151.33	137.87			44.08	0.73	1.25
	15-30	M78	264.16	234.72			43.98	0.77	1.32
	30-60	M79	395.7	342.9			44.02	0.57	0.98
	60-100	M80	501.89	442.55			43.97	0.38	0.66
Coordinates	30	344537E	4183628N	152m					
Lane 11	0-15	M81	175.09	153.44			44.06	0.70	1.21
	15-30	M82	214.09	183.49			44.09	0.52	0.90
	30-60	M83	418.7	352.48			44.16	0.42	0.72
	60-100	M84	580.7	491.23			44.04	0.40	0.68
Coordinates	30	344621E	4183598N	146m					
Under tree 11	0-15	M85	134.57	123.83			43.38	0.85	1.47
	15-30	M86	214.15	187.55			43.94	0.70	1.21
	30-60	M87	468.67	402.47			44.1	0.48	0.83
	60-100	M88	608.16	537.59			44.06	0.40	0.69
Coordinates	30	344616E	4183596N	145m					

Lane 12	0-15	M89	198.7	174.23			44.28	0.82	1.42
	15-30	M90	250.92	213.23			44.1	0.66	1.13
	30-60	M91	412.88	353.97			44.06	0.50	0.86
	60-100	M92	591.8	525.72			44.26	0.33	0.56
Coordinates	30	344724E	4183569N	146m					
Under tree 12	0-15	M93	168.52	153.89			44.3	0.72	1.23
	15-30	M94	245.04	212.59			44.32	0.63	1.08
	30-60	M95	414.06	362.44			44.35	0.45	0.78
	60-100	M96	551.26	480.09			44.31	0.37	0.63
Coordinates	30	344718E	4183565N	140m					
Lane 13	0-15	M97	191.24	170.67			44.13	0.94	1.62
	15-30	M98	263.38	230.29			44.03	0.68	1.17
	30-60	M99	471.48	409.8			44.04	0.52	0.89
	60-100	M100	594.89	518			43.98	0.49	0.84
Coordinates	30	344255E	4183683N	185m					
Under tree 13	0-15	M101	175.19	160.76	102.56	101.9	44.53	0.67	1.16
	15-30	M102	238.52	212.33	86.97	86.27	44.09	0.55	0.94
	30-60	M103	423.14	369.34	124.07	121.95	43.46	0.51	0.88
	60-100	M104	572.72	511.41	123.18	121.39	43.77	0.64	1.10
Coordinates	30	344255E	4183680N	185m					
Lane 14	0-15	M105	196.15	177.81			44.01	0.68	1.17
	15-30	M106	262.19	231.07			44.01	0.58	1.00
	30-60	M107	396.14	342.38			43.99	0.49	0.84
	60-100	M108	611.06	534.02			44.33	0.28	0.49
Coordinates	30	344329E	4183662N	176m					
Under tree 14	0-15	M109	169.92	156.88			44.02	0.90	1.55
	15-30	M110	211.18	190.24			43.27	0.83	1.44
	30-60	M111	289.05	255.45			43.96	0.48	0.83
	60-100	M112	176.68	158.32			44	0.45	0.77
Coordinates	30	344328E	4183660N	176m					
Lane 15	0-15	M113	229.01	200.43			44.31	0.68	1.17
	15-30	M114	279.42	239.18			44.51	0.55	0.94
	30-60	M115	445.86	372.15			44.59	0.53	0.92
	60-100	M116	658.58	587.3			44.56	0.37	0.65
Coordinates	30	344455E	4183622N	167m					
Under tree 15	0-15	M117	182.55	166.7			43.91	0.57	0.98
	15-30	M118	267.85	235.36			44.58	0.57	0.99
	30-60	M119	419.07	368.07			44.57	0.50	0.86
	60-100	M120	508.5	477.94			44.56	0.32	0.55
Coordinates	30	344453E	4183618N	166m					

Lane 16	0-15	M121	241.3	209.4			44.36	0.78	1.34
	15-30	M122	255.13	221.84			43.58	0.54	0.93
	30-60	M123	441.6	380.37			44.19	0.34	0.58
	60-100	M124	575.74	496			44.21	0.24	0.41
Coordinates	30	344521E	4183599N	156m					
Under tree 16	0-15	M125	177.26	160.78			44.39	0.69	1.19
	15-30	M126	253.03	224.99			44.35	0.54	0.93
	30-60	M127	451.18	392.15			43.68	0.39	0.68
	60-100	M128	556.51	498.84			44.31	0.31	0.54
Coordinates	30	344516E	4183598N	160m					
Lane 17	0-15	M129	210.83	184.97			44.16	0.78	1.34
	15-30	M130	222.27	191.38			43.6	0.58	1.01
	30-60	M131	474.74	399.92			43.85	0.46	0.80
	60-100	M132	577.79	506.74			43.88	0.35	0.61
Coordinates	30	344615E	4183571N	149m					
Under tree 17	0-15	M133	157.07	142.15			44.1	0.84	1.46
	15-30	M134	231.12	204.73			44.33	0.48	0.83
	30-60	M135	304.58	262.44			43.83	0.56	0.97
	60-100	M136	580.63	503.15			43.78	0.36	0.61
Coordinates	30	344612E	4183567N	146m					
Lane 18	0-15	M137	188.53	167.05			44.42	0.97	1.67
	15-30	M138	229.86	196.75			44.44	0.59	1.01
	30-60	M139	475.5	403.77			44.41	0.42	0.72
	60-100	M140	599.69	525.73			44.43	0.38	0.65
Coordinates	30	344710E	4183539N	141m					
Under tree 18	0-15	M141	153.48	139.43			43.81	1.03	1.77
	15-30	M142	255.36	221.17			44.3	0.71	1.22
	30-60	M143	403.53	348.38			43.86	0.45	0.77
	60-100	M144	533.18	469.37			43.84	0.32	0.55
Coordinates	30	344705E	4183539N	142m					

La Teja

Soil sampling									
Date:	***27/02/2015***	***03/03/2015***							
Field:	***La Teja***								
			With lid		Without lid		With lid		
Spot/ location	Depth (cm)	**reference**	Total weigth	Dry weigth 35 °C	Weigth subm	Weigth subm 105°C	(g)	%C	%OM
Lane 1	0-15	T1	243.13	221.21			44.29	0.32	0.55
	15-30	T2	227.83	207.17			45.59	0.12	0.21
	30-60	T3	371.64	359.65			43.44	0.07	0.12
	60-100	T4	501.48	473.93			44.38	0.04	0.06
Coordinates	30	349156E	4180653N	274m					
Under tree 1	0-15	T5	206.22	187.37	63.87	63.86	34.43	0.36	0.62
	15-30	T6	292.52	264	71.9	71.6	34.48	0.27	0.47
	30-60	T7	537.59	484.31	150.76	149.93	35.26	0.07	0.12
	60-90	T8	526.2	502.8	93.12	92.7	34.14	0.01	0.01
Coordinates	30	349152E	4180649N						
Lane 2	0-15	T9	272.46	244.91			43.14	0.55	0.95
	15-30	T10	292.05	266.58			44.11	0.55	0.95
	30-60	T11	433.64	393.24			47.02	0.52	0.90
	60-100	T12	628.14	563.38			44.04	0.34	0.59
Coordinates	30	349143E	4180697N						
Under tree 2	0-15	T13	186.76	167.96			42.6	0.61	1.05
	15-30	T14	260.36	228.97			43.5	0.74	1.28
	30-60	T15	496.36	432.19			43.62	0.64	1.10
	60-100	T16	695.59	603.78			43.42	0.47	0.82
Coordinates	30	349139E	4180699N						
Lane 3	0-15	T17	261.85	238.98			44.63	0.37	0.64
	15-30	T18	271.77	250.33			44.47	0.19	0.33
	30-60	T19	479.39	454.54			45.06	0.12	0.20
	60-90	T20	542.72	506.51			43.58	0.01	0.02
Coordinates	30	349132E	4180751N						
Under tree 3	0-15	T21	211.59	192.75			42.84	0.40	0.69
	15-30	T22	214.89	192.87			44.5	0.15	0.25
	30-60	T23	522.26	472.34			43.6	0.14	0.24
	60-87	T24	556.02	518.43			43.44	0.04	0.06
Coordinates	30	349130E	4180749N						

Lane 4	0-15	T25	249.21	229.97			43.17	0.53	0.91
	15-30	T26	296.8	285.35			43.22	0.08	0.13
	30-52	T27	411.1	392.71			44.37	0.01	0.01
		T28	No sample					0.01	
Coordinates	30	349114E	4180809N						
Under tree 4	0-15	T29	198.23	184.6			43.92	0.37	0.63
	15-30	T30	221.75	204.37			43.89	0.35	0.60
	30-60	T31	505.87	475.1			43.96	0.10	0.18
	60-94	T32	536.39	492.75			45.49	0.08	0.14
Coordinates	30	349115E	4180808N						
Lane 5	0-15	T33	292.14	261.61	88.9	88.51	36.02	0.16	0.27
	15-30	T34	275.97	242.21	88.09	87.24	34.2	0.13	0.23
	30-60	T35	473.29	418.06	127	125.37	34.64	0.06	0.11
	60-100	T36	576.62	527.27	136.9	133.47	34.65	0.16	0.27
Coordinates	30	349102E	4180866N						
Under tree 5	0-15	T37	199.19	184.9			43.81	0.29	0.49
	15-30	T38	238.66	216.93			43.46	0.26	0.44
	30-60	T39	456.32	409.52			43.95	0.10	0.17
	60-100	T40	499.04	454.52			42.92	0.02	0.03
Coordinates	30	349096E	4180867N						
Lane 6	0-15	T41	301.24	272.24			42.85	0.28	0.48
	15-30	T42	232.77	208.52			44.81	0.26	0.45
	30-60	T43	416.27	375.03			44.17	0.16	0.27
	60-100	T44	541.2	504.97			42.55	0.01	0.02
Coordinates	30	349076E	4180965N						
Under tree 6	0-15	T45	220.35	201.51			43.3	0.40	0.68
	15-30	T46	255.58	229.7			43.71	0.42	0.72
	30-60	T47	522.6	461.65			43.34	0.13	0.23
	60-85	T48	442.63	407.52			42.9	0.13	0.22
Coordinates	30	349076E	4180962N						
Lane 7	0-15	T49	208.98	195.49			45.03	0.25	0.42
	15-30	T50	265.34	242.47			43.29	0.10	0.17
	30-60	T51	342.67	313.03			43.94	0.10	0.18
	60-100	T52	442.52	410.21			44.56	0.01	0.01
Coordinates	30	349130E	4180634N						
Under tree 7	0-15	T53	169.44	157.87			43.31	0.85	1.46
	15-30	T54	223.05	203.11			44.11	0.37	0.64
	30-60	T55	No sample					0.16	
	60-100	T56	No sample					0.15	
Coordinates	30	349122E	4180640N						

Lane 8	0-15	T57	221.42	201.94			42.54	0.57	0.99
	15-30	T58	222.4	204.71			44.67	0.46	0.79
	30-60	T59	355.21	330.67			45.65	0.23	0.39
	60-100	T60	348.5	324.25			43.67	0.09	0.16
Coordinates	30	349114E	4180691N						
Under tree 8	0-15	T61	146.84	133.83			42.11	0.50	0.86
	15-30	T62	195.42	173.76			43.74	0.51	0.87
	30-60	T63	411.94	358.65			45.84	0.34	0.58
	60-100	T64	413.26	371.84			43.14	0.17	0.29
Coordinates	30	349114E	4180688N						
Lane 9	0-15	T65	207.15	189.94			43.13	0.53	0.92
	15-30	T66	229.83	210.88			43.14	0.20	0.34
	30-60	T67	410.43	374.4			43.28	0.14	0.24
	60-100	T68	309.62	281.41			44.65	0.10	0.17
Coordinates	30	349101E	4180743N						
Under tree 9	0-15	T69	152.94	140.78	57.53	57.51	34.47	0.58	1.00
	15-30	T70	243.17	214.65	88.31	87.75	33.84	0.40	0.70
	30-60	T71	438.68	390.69	89.74	89.5	35.23	0.22	0.39
	60-100	T72	470.87	432.46	138.55	138.08	34.8	0.04	0.07
Coordinates	30	349100E	4180744N						
Lane 10	0-15	T73	218.17	198.78			44.74	0.45	0.77
	15-30	T74	186.05	168.49			45.04	0.36	0.61
	30-60	T75	348.89	344.88			43.45	0.37	0.64
	60-100	T76	532.17	490.43			44.04	0.28	0.48
Coordinates	30	349087E	4180796N						
Under tree 10	0-15	T77	167.85	153.92			43.53	0.66	1.14
	15-30	T78	205.82	185.48			43.4	0.49	0.84
	30-60	T79	357.93	318.53			42.67	0.42	0.73
	60-93	T80	428.96	386.03			44.15	0.38	0.66
Coordinates	30	349083E	4180798N						
Lane 11	0-15	T81	196.96	177.96			42.59	0.27	0.47
	15-30	T82	233.81	207.9			42.98	0.18	0.30
	30-60	T83	399.78	363.32			45.01	0.14	0.24
	60-100	T84	569.35	523.08			44.13	0.01	0.02
Coordinates	30	349076E	4180855N						
Under tree 11	0-15	T85	193.24	176.98			45.57	0.41	0.71
	15-30	T86	214.83	189.96			44.09	0.22	0.38
	30-60	T87	367.55	321.37			45.33	0.15	0.26
	60-70	T88	256.05	230.4			45.02	0.16	0.28
Coordinates	30	349070E	4180854N						

Lane 12	0-15	T89	202.36	183.83			44.07	0.61	1.04
	15-30	T90	221.49	199.49			43.5	0.67	1.16
	30-60	T91	321.7	285.31			44.47	0.33	0.57
	60-100	T92	510.54	468.2			44.19	0.19	0.33
Coordinates	30	349058E	4180923N						
Under tree 12	0-15	T93	159.45	146.29			44.04	0.78	1.34
	15-30	T94	224.58	201.76			44.37	0.47	0.80
	30-60	T95	433.49	376			43.61	0.39	0.68
	60-72	T96	202.49	183.34			45.56	0.25	0.42
Coordinates	30	349059E	4180919N						
Lane 13	0-15	T97	246.22	226.13	79.25	79.14	34.56	0.40	0.69
	15-30	T98	261.31	239.9	63.57	63.58	34.49	0.56	0.96
	30-60	T99	416.92	382.48	78.47	78.3	34.48	0.29	0.51
	60-100	T100	487.23	451.6	103.29	102.97	36.38	0.32	0.55
Coordinates	30								
Under tree 13	0-15	T101	191.34	176.74			43.56	0.64	1.10
	15-30	T102	232.41	212.3			42.67	0.53	0.91
	30-60	T103	408.16	365.61			42.91	0.43	0.75
	60-100	T104	419.63	384.08			43.71	0.46	0.80
Coordinates	30								
Lane 14	0-15	T105	216.45	196.97			43.06	0.50	0.87
	15-30	T106	218.36	197.07			44.42	0.38	0.66
	30-60	T107	373.97	343.61			44.1	0.11	0.20
	60-100	T108	470.13	435.34			42.78	0.11	0.19
Coordinates	30								
Under tree 14	0-15	T109	165.83	151.89			43.6	0.54	0.93
	15-30	T110	226.4	200.41			42.79	0.62	1.06
	30-60	T111	416.31	365.5			43.56	0.21	0.37
	60-100	T112	282.59	259.39			45.94	0.21	0.36
Coordinates	30								
Lane 15	0-15	T113	200.86	185.15			43.69	0.61	1.06
	15-30	T114	227.08	205.51			42.78	0.25	0.43
	30-60	T115	411.9	377.84			42.63	0.25	0.44
	60-100	T116	211.34	202.09			43.16	0.19	0.33
Coordinates	30								
Under tree 15	0-15	T117	192.17	177.08			44.3	0.72	1.24
	15-30	T118	248.75	224.65			44.35	0.57	0.99
	30-60	T119	412.44	377.29			45.6	0.12	0.21
	60-100	T120	No sample					0.03	
Coordinates	30								

Lane 16	0-15	T121	212.59	196.36			43.38	0.24	0.42
	15-30	T122	213.75	204.11			44.73	0.09	0.16
	30-60	T123	444.63	409.26			43.91	0.08	0.14
	60-100	T124	587.48	563.23			43.07	0.07	0.12
Coordinates	30								
Under tree 16	0-15	T125	212.73	195.1			43.51	0.42	0.72
	15-30	T126	187.17	171.66			44.24	0.20	0.35
	30-60	T127	428.37	404.39			43.93	0.07	0.12
	60-100	T128	495.56	453.5			45.06	0.12	0.21
Coordinates	30								
Lane 17	0-15	T129	206.31	189.8	67.2	67.08	34.22	0.49	0.84
	15-30	T130	205.73	184.47	63.45	63.28	34.7	0.40	0.69
	30-60	T131	433.79	391.16			42.89	0.18	0.30
	60-100	T132	232.58	217.19			44.05	0.24	0.41
Coordinates	30								
Under tree 17	0-15	T133	176.69	164.13			43.26	0.64	1.11
	15-30	T134	196.87	179.85			42.66	0.39	0.67
	30-60	T135	374.92	336.82	74.24	74.01	34.23	0.20	0.35
	60-100	T136	343.21	316.73	75.29	75.06	34.18	0.07	0.12
Coordinates	30								
Lane 18	0-15	T137	221.99	205.69			42.66	0.42	0.73
	15-30	T138	204.39	188.68			43.15	0.54	0.93
	30-60	T139	351.12	316.56			43.06	0.51	0.88
	60-100	T140	471.32	429.61			43.42	0.32	0.54
Coordinates	30								
Under tree 18	0-15	T141	162.66	148.89			43.15	0.80	1.37
	15-30	T142	213.88	193.49			43.26	0.56	0.97
	30-60	T143	378.32	336.34			42.8	0.37	0.64
	60-100	T144	319.95	292.54			44.32	0.32	0.54
Coordinates	30								

Soil sampling									
Date:	***27/02/2015***	***03/03/2015***							
Field:	***La Teja***								
			With lid		Without lid		With lid		
Spot/ location	Depth (cm)	**reference**	Total weigth	Dry weigth 35 °C	Weigth subm	Weigth subm 105°C	(g)	%C	%OM
Lane 1	0-15	T1	243.13	221.21			44.29	0.32	0.55
	15-30	T2	227.83	207.17			45.59	0.12	0.21
	30-60	T3	371.64	359.65			43.44	0.07	0.12
	60-100	T4	501.48	473.93			44.38	0.04	0.06
Coordinates	30	349156E	4180653N	274m					
Under tree 1	0-15	T5	206.22	187.37	63.87	63.86	34.43	0.36	0.62
	15-30	T6	292.52	264	71.9	71.6	34.48	0.27	0.47
	30-60	T7	537.59	484.31	150.76	149.93	35.26	0.07	0.12
	60-90	T8	526.2	502.8	93.12	92.7	34.14	0.01	0.01
Coordinates	30	349152E	4180649N						
Lane 2	0-15	T9	272.46	244.91			43.14	0.55	0.95
	15-30	T10	292.05	266.58			44.11	0.55	0.95
	30-60	T11	433.64	393.24			47.02	0.52	0.90
	60-100	T12	628.14	563.38			44.04	0.34	0.59
Coordinates	30	349143E	4180697N						
Under tree 2	0-15	T13	186.76	167.96			42.6	0.61	1.05
	15-30	T14	260.36	228.97			43.5	0.74	1.28
	30-60	T15	496.36	432.19			43.62	0.64	1.10
	60-100	T16	695.59	603.78			43.42	0.47	0.82
Coordinates	30	349139E	4180699N						
Lane 3	0-15	T17	261.85	238.98			44.63	0.37	0.64
	15-30	T18	271.77	250.33			44.47	0.19	0.33
	30-60	T19	479.39	454.54			45.06	0.12	0.20
	60-90	T20	542.72	506.51			43.58	0.01	0.02
Coordinates	30	349132E	4180751N						
Under tree 3	0-15	T21	211.59	192.75			42.84	0.40	0.69
	15-30	T22	214.89	192.87			44.5	0.15	0.25
	30-60	T23	522.26	472.34			43.6	0.14	0.24
	60-87	T24	556.02	518.43			43.44	0.04	0.06
Coordinates	30	349130E	4180749N						

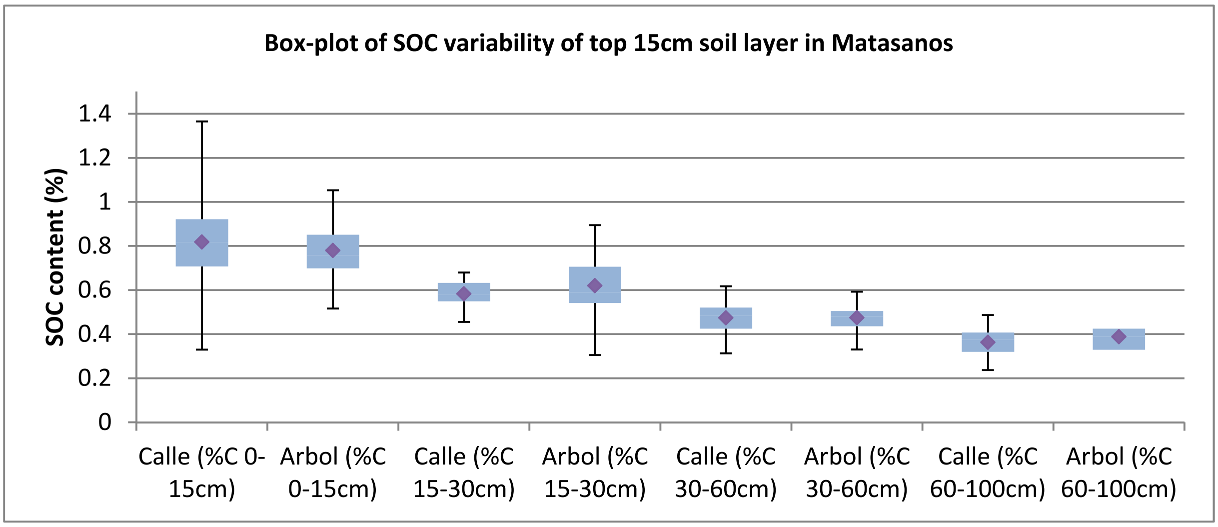
Lane 4	0-15	T25	249.21	229.97			43.17	0.53	0.91
	15-30	T26	296.8	285.35			43.22	0.08	0.13
	30-52	T27	411.1	392.71			44.37	0.01	0.01
		T28	No sample					0.01	
Coordinates	30	349114E	4180809N						
Under tree 4	0-15	T29	198.23	184.6			43.92	0.37	0.63
	15-30	T30	221.75	204.37			43.89	0.35	0.60
	30-60	T31	505.87	475.1			43.96	0.10	0.18
	60-94	T32	536.39	492.75			45.49	0.08	0.14
Coordinates	30	349115E	4180808N						
Lane 5	0-15	T33	292.14	261.61	88.9	88.51	36.02	0.16	0.27
	15-30	T34	275.97	242.21	88.09	87.24	34.2	0.13	0.23
	30-60	T35	473.29	418.06	127	125.37	34.64	0.06	0.11
	60-100	T36	576.62	527.27	136.9	133.47	34.65	0.16	0.27
Coordinates	30	349102E	4180866N						
Under tree 5	0-15	T37	199.19	184.9			43.81	0.29	0.49
	15-30	T38	238.66	216.93			43.46	0.26	0.44
	30-60	T39	456.32	409.52			43.95	0.10	0.17
	60-100	T40	499.04	454.52			42.92	0.02	0.03
Coordinates	30	349096E	4180867N						
Lane 6	0-15	T41	301.24	272.24			42.85	0.28	0.48
	15-30	T42	232.77	208.52			44.81	0.26	0.45
	30-60	T43	416.27	375.03			44.17	0.16	0.27
	60-100	T44	541.2	504.97			42.55	0.01	0.02
Coordinates	30	349076E	4180965N						
Under tree 6	0-15	T45	220.35	201.51			43.3	0.40	0.68
	15-30	T46	255.58	229.7			43.71	0.42	0.72
	30-60	T47	522.6	461.65			43.34	0.13	0.23
	60-85	T48	442.63	407.52			42.9	0.13	0.22
Coordinates	30	349076E	4180962N						
Lane 7	0-15	T49	208.98	195.49			45.03	0.25	0.42
	15-30	T50	265.34	242.47			43.29	0.10	0.17
	30-60	T51	342.67	313.03			43.94	0.10	0.18
	60-100	T52	442.52	410.21			44.56	0.01	0.01
Coordinates	30	349130E	4180634N						
Under tree 7	0-15	T53	169.44	157.87			43.31	0.85	1.46
	15-30	T54	223.05	203.11			44.11	0.37	0.64
	30-60	T55	No sample					0.16	
	60-100	T56	No sample					0.15	
Coordinates	30	349122E	4180640N						

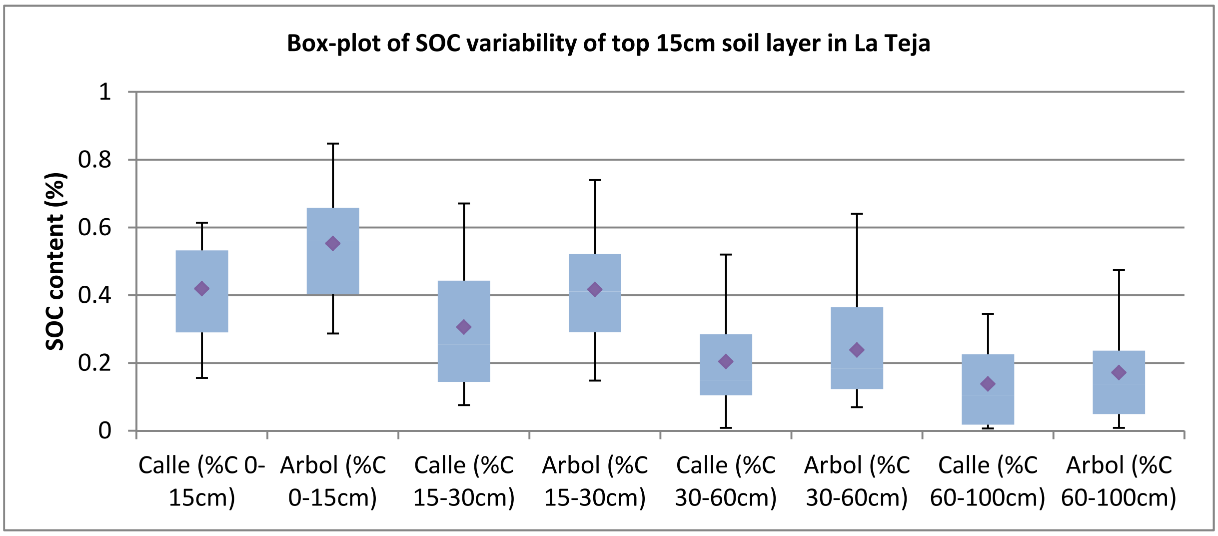
Lane 8	0-15	T57	221.42	201.94			42.54	0.57	0.99
	15-30	T58	222.4	204.71			44.67	0.46	0.79
	30-60	T59	355.21	330.67			45.65	0.23	0.39
	60-100	T60	348.5	324.25			43.67	0.09	0.16
Coordinates	30	349114E	4180691N						
Under tree 8	0-15	T61	146.84	133.83			42.11	0.50	0.86
	15-30	T62	195.42	173.76			43.74	0.51	0.87
	30-60	T63	411.94	358.65			45.84	0.34	0.58
	60-100	T64	413.26	371.84			43.14	0.17	0.29
Coordinates	30	349114E	4180688N						
Lane 9	0-15	T65	207.15	189.94			43.13	0.53	0.92
	15-30	T66	229.83	210.88			43.14	0.20	0.34
	30-60	T67	410.43	374.4			43.28	0.14	0.24
	60-100	T68	309.62	281.41			44.65	0.10	0.17
Coordinates	30	349101E	4180743N						
Under tree 9	0-15	T69	152.94	140.78	57.53	57.51	34.47	0.58	1.00
	15-30	T70	243.17	214.65	88.31	87.75	33.84	0.40	0.70
	30-60	T71	438.68	390.69	89.74	89.5	35.23	0.22	0.39
	60-100	T72	470.87	432.46	138.55	138.08	34.8	0.04	0.07
Coordinates	30	349100E	4180744N						
Lane 10	0-15	T73	218.17	198.78			44.74	0.45	0.77
	15-30	T74	186.05	168.49			45.04	0.36	0.61
	30-60	T75	348.89	344.88			43.45	0.37	0.64
	60-100	T76	532.17	490.43			44.04	0.28	0.48
Coordinates	30	349087E	4180796N						
Under tree 10	0-15	T77	167.85	153.92			43.53	0.66	1.14
	15-30	T78	205.82	185.48			43.4	0.49	0.84
	30-60	T79	357.93	318.53			42.67	0.42	0.73
	60-93	T80	428.96	386.03			44.15	0.38	0.66
Coordinates	30	349083E	4180798N						
Lane 11	0-15	T81	196.96	177.96			42.59	0.27	0.47
	15-30	T82	233.81	207.9			42.98	0.18	0.30
	30-60	T83	399.78	363.32			45.01	0.14	0.24
	60-100	T84	569.35	523.08			44.13	0.01	0.02
Coordinates	30	349076E	4180855N						
Under tree 11	0-15	T85	193.24	176.98			45.57	0.41	0.71
	15-30	T86	214.83	189.96			44.09	0.22	0.38
	30-60	T87	367.55	321.37			45.33	0.15	0.26
	60-70	T88	256.05	230.4			45.02	0.16	0.28
Coordinates	30	349070E	4180854N						

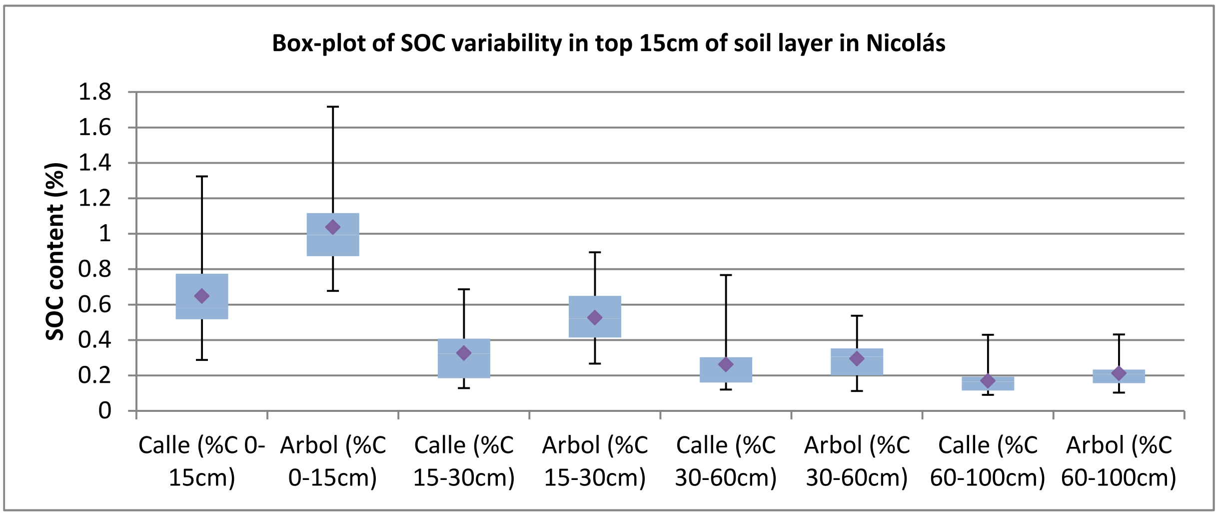
Lane 12	0-15	T89	202.36	183.83			44.07	0.61	1.04
	15-30	T90	221.49	199.49			43.5	0.67	1.16
	30-60	T91	321.7	285.31			44.47	0.33	0.57
	60-100	T92	510.54	468.2			44.19	0.19	0.33
Coordinates	30	349058E	4180923N						
Under tree 12	0-15	T93	159.45	146.29			44.04	0.78	1.34
	15-30	T94	224.58	201.76			44.37	0.47	0.80
	30-60	T95	433.49	376			43.61	0.39	0.68
	60-72	T96	202.49	183.34			45.56	0.25	0.42
Coordinates	30	349059E	4180919N						
Lane 13	0-15	T97	246.22	226.13	79.25	79.14	34.56	0.40	0.69
	15-30	T98	261.31	239.9	63.57	63.58	34.49	0.56	0.96
	30-60	T99	416.92	382.48	78.47	78.3	34.48	0.29	0.51
	60-100	T100	487.23	451.6	103.29	102.97	36.38	0.32	0.55
Coordinates	30								
Under tree 13	0-15	T101	191.34	176.74			43.56	0.64	1.10
	15-30	T102	232.41	212.3			42.67	0.53	0.91
	30-60	T103	408.16	365.61			42.91	0.43	0.75
	60-100	T104	419.63	384.08			43.71	0.46	0.80
Coordinates	30								
Lane 14	0-15	T105	216.45	196.97			43.06	0.50	0.87
	15-30	T106	218.36	197.07			44.42	0.38	0.66
	30-60	T107	373.97	343.61			44.1	0.11	0.20
	60-100	T108	470.13	435.34			42.78	0.11	0.19
Coordinates	30								
Under tree 14	0-15	T109	165.83	151.89			43.6	0.54	0.93
	15-30	T110	226.4	200.41			42.79	0.62	1.06
	30-60	T111	416.31	365.5			43.56	0.21	0.37
	60-100	T112	282.59	259.39			45.94	0.21	0.36
Coordinates	30								
Lane 15	0-15	T113	200.86	185.15			43.69	0.61	1.06
	15-30	T114	227.08	205.51			42.78	0.25	0.43
	30-60	T115	411.9	377.84			42.63	0.25	0.44
	60-100	T116	211.34	202.09			43.16	0.19	0.33
Coordinates	30								
Under tree 15	0-15	T117	192.17	177.08			44.3	0.72	1.24
	15-30	T118	248.75	224.65			44.35	0.57	0.99
	30-60	T119	412.44	377.29			45.6	0.12	0.21
	60-100	T120	No sample					0.03	
Coordinates	30								

Lane 16	0-15	T121	212.59	196.36			43.38	0.24	0.42
	15-30	T122	213.75	204.11			44.73	0.09	0.16
	30-60	T123	444.63	409.26			43.91	0.08	0.14
	60-100	T124	587.48	563.23			43.07	0.07	0.12
Coordinates	30								
Under tree 16	0-15	T125	212.73	195.1			43.51	0.42	0.72
	15-30	T126	187.17	171.66			44.24	0.20	0.35
	30-60	T127	428.37	404.39			43.93	0.07	0.12
	60-100	T128	495.56	453.5			45.06	0.12	0.21
Coordinates	30								
Lane 17	0-15	T129	206.31	189.8	67.2	67.08	34.22	0.49	0.84
	15-30	T130	205.73	184.47	63.45	63.28	34.7	0.40	0.69
	30-60	T131	433.79	391.16			42.89	0.18	0.30
	60-100	T132	232.58	217.19			44.05	0.24	0.41
Coordinates	30								
Under tree 17	0-15	T133	176.69	164.13			43.26	0.64	1.11
	15-30	T134	196.87	179.85			42.66	0.39	0.67
	30-60	T135	374.92	336.82	74.24	74.01	34.23	0.20	0.35
	60-100	T136	343.21	316.73	75.29	75.06	34.18	0.07	0.12
Coordinates	30								
Lane 18	0-15	T137	221.99	205.69			42.66	0.42	0.73
	15-30	T138	204.39	188.68			43.15	0.54	0.93
	30-60	T139	351.12	316.56			43.06	0.51	0.88
	60-100	T140	471.32	429.61			43.42	0.32	0.54
Coordinates	30								
Under tree 18	0-15	T141	162.66	148.89			43.15	0.80	1.37
	15-30	T142	213.88	193.49			43.26	0.56	0.97
	30-60	T143	378.32	336.34			42.8	0.37	0.64
	60-100	T144	319.95	292.54			44.32	0.32	0.54
Coordinates	30								

Appendix 2: Box-plots of SOC variability of first 15 cm of soil layers







Appendix 3: T-tests SOC dependency sampling areas

Matasanos

T-test: two samples with unequal variances	%SOC 0-15cm	
	Calle	*Arbol*
Mean	0,818110835	0,779551783
Variance	0,043224007	0,018906015
Observations	18	18
Hypothesized Mean Difference	0	
df	29	
T- stat	0,656314282	
P (T <= t) one-tail	0,258398102	
t Critical one-tail	1,699127027	
P(T<=t) Two-tail	0,516796205	
t Critical two-tail	2,045229642	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

T-test: two samples with unequal variances	%SOC 30-60cm	
	Calle	*Arbol*
Mean	0,473762336	0,474560238
Variance	0,005754569	0,00483076
Observations	18	18
Hypothesized Mean Difference	0	
df	34	
T- stat	-0,032902857	
P (T <= t) one-tail	0,486972228	
t Critical one-tail	1,690924255	
P(T<=t) Two-tail	0,973944457	
t Critical two-tail	2,032244509	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

T-test: two samples with unequal variances	%SOC 15-30cm	
	Calle	*Arbol*
Mean	0,582604574	0,619749628
Variance	0,004070961	0,019768339
Observations	18	18
Hypothesized Mean Difference	0	
df	24	
T- stat	-1,020682096	
P (T <= t) one-tail	0,158792111	
t Critical one-tail	1,71088208	
P(T<=t) Two-tail	0,317584221	
t Critical two-tail	2,063898562	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

T-test: two samples with unequal variances	%SOC 60-100cm	
	Calle	*Arbol*
Mean	0,362924579	0,388029772
Variance	0,005125155	0,010226044
Observations	18	18
Hypothesized Mean Difference	0	
df	31	
T- stat	-0,859663838	
P (T <= t) one-tail	0,198286926	
t Critical one-tail	1,695518783	
P(T<=t) Two-tail	0,396573851	
t Critical two-tail	2,039513446	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

La Teja

T-test: two samples with unequal variances	%SOC 0-15cm	
	Calle	Arbol
Mean	0,419472897	0,552931641
Variance	0,019662008	0,028733858
Observations	18	18
Hypothesized Mean Difference	0	
df	33	
T- stat	-2,573825808	
P (T <= t) one-tail	0,007368196	
t Critical one-tail	1,692360309	
P(T<=t) Two-tail	0,014736392	
t Critical two-tail	2,034515297	
	t-stat<-T Critical	True
	t-stat> T Critical	False
Null-hypothesis approved, convincing differences: Land units do differ significantly		

T-test: two samples with unequal variances	%SOC 30-60cm	
	Calle	Arbol
Mean	0,204338519	0,238388116
Variance	0,022233058	0,025265872
Observations	18	18
Hypothesized Mean Difference	0	
df	34	
T- stat	-0,662836351	
P (T <= t) one-tail	0,255952122	
t Critical one-tail	1,690924255	
P(T<=t) Two-tail	0,511904244	
t Critical two-tail	2,032244509	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

T-test: two samples with unequal variances	%SOC 15-30cm	
	Calle	Arbol
Mean	0,305938846	0,417154343
Variance	0,035541439	0,025189412
Observations	18	18
Hypothesized Mean Difference	0	
df	33	
T- stat	-1,91468297	
P (T <= t) one-tail	0,032117798	
t Critical one-tail	1,692360309	
P(T<=t) Two-tail	0,064235595	
t Critical two-tail	2,034515297	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

T-test: two samples with unequal variances	%SOC 60-100cm	
	Calle	Arbol
Mean	0,138149218	0,171610084
Variance	0,014432045	0,022350226
Observations	18	18
Hypothesized Mean Difference	0	
df	32	
T- stat	-0,740208634	
P (T <= t) one-tail	0,232285015	
t Critical one-tail	1,693888748	
P(T<=t) Two-tail	0,464570031	
t Critical two-tail	2,036933343	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

Nicolás

T-test: two samples with unequal variances	%SOC 0-15cm	
	Calle	*Arbol*
Mean	0,647674382	1,037179744
Variance	0,069027427	0,070167723
Observations	18	18
Hypothesized Mean Difference	0	
df	34	
T- stat	-4,429325965	
P (T <= t) one-tail	4,65686E-05	
t Critical one-tail	1,690924255	
P(T<=t) Two-tail	9,31372E-05	
t Critical two-tail	2,032244509	
	t-stat<-T Critical	True
	t-stat> T Critical	False
Null-hypothesis approved, convincing differences: Land units do differ significantly		

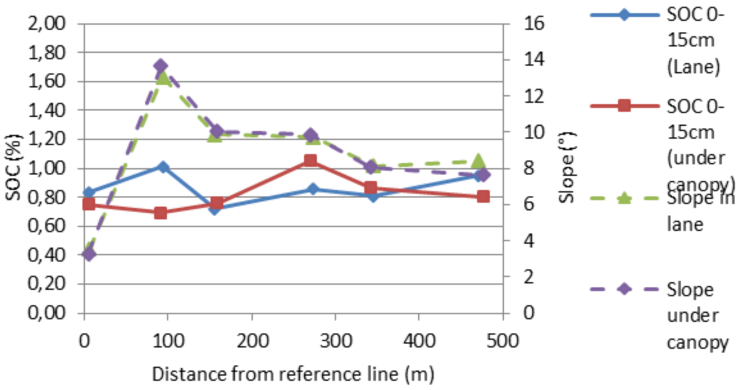
T-test: two samples with unequal variances	%SOC 30-60cm	
	Calle	*Arbol*
Mean	0,262260328	0,294081544
Variance	0,030733505	0,015516932
Observations	18	18
Hypothesized Mean Difference	0	
df	31	
T- stat	-0,627762122	
P (T <= t) one-tail	0,267378593	
t Critical one-tail	1,695518783	
P(T<=t) Two-tail	0,534757187	
t Critical two-tail	2,039513446	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

T-test: two samples with unequal variances	%SOC 15-30cm	
	Calle	*Arbol*
Mean	0,325763553	0,526153646
Variance	0,027014332	0,03156867
Observations	18	18
Hypothesized Mean Difference	0	
df	34	
T- stat	-3,512583742	
P (T <= t) one-tail	0,000637981	
t Critical one-tail	1,690924255	
P(T<=t) Two-tail	0,001275962	
t Critical two-tail	2,032244509	
	t-stat<-T Critical	True
	t-stat> T Critical	False
Null-hypothesis approved, convincing differences: Land units do differ significantly		

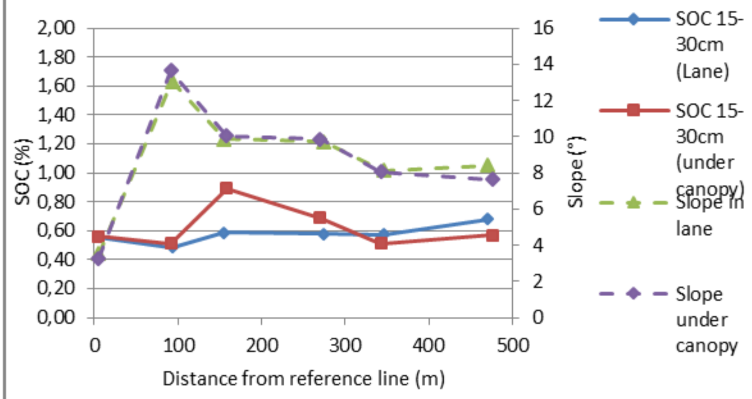
T-test: two samples with unequal variances	%SOC 60-100cm	
	Calle	*Arbol*
Mean	0,32760163	0,212094322
Variance	0,478585762	0,006339251
Observations	18	18
Hypothesized Mean Difference	0	
df	17	
T- stat	0,70373382	
P (T <= t) one-tail	0,245563017	
t Critical one-tail	1,739606726	
P(T<=t) Two-tail	0,491126034	
t Critical two-tail	2,109815578	
	t-stat<-T Critical	False
	t-stat> T Critical	False
Null-hypothesis rejected, no convincing differences: Land units do not differ significantly		

Appendix 4: SOC variability along transects

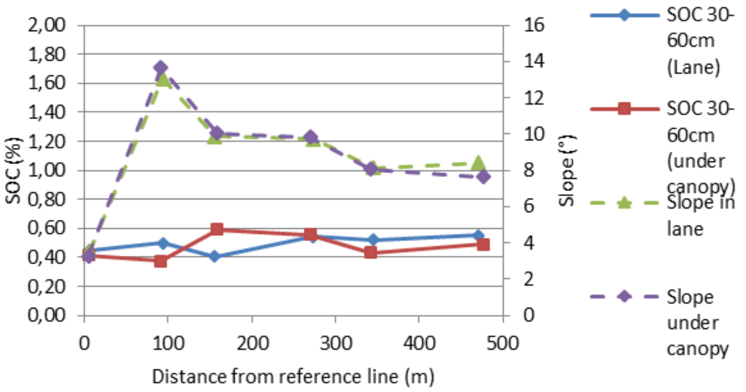
SOC variability in transect 1 (0-15cm), Matasanos



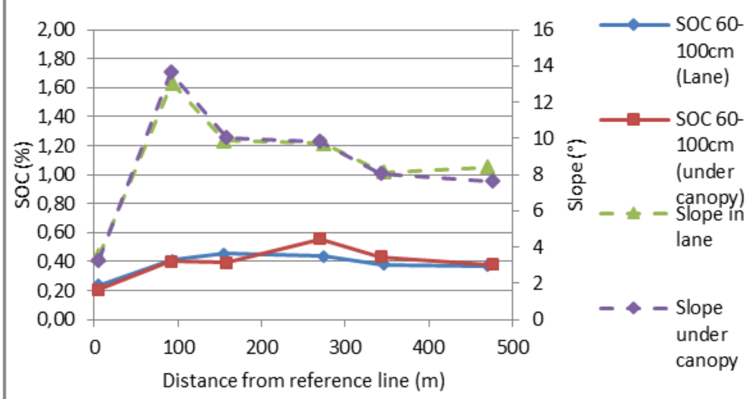
SOC variability in transect 1 (15-30cm), Matasanos



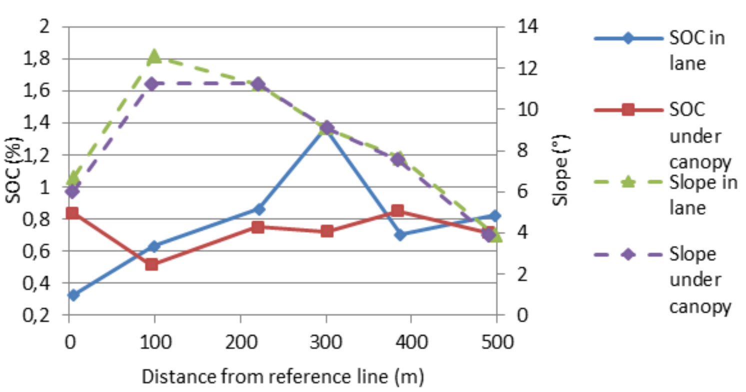
SOC variability in transect 1 (30-60cm), Matasanos



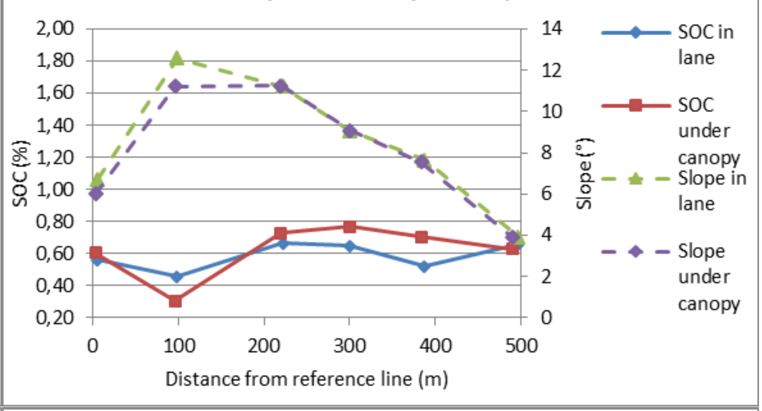
SOC variability in transect 1 (60-100cm), Matasanos



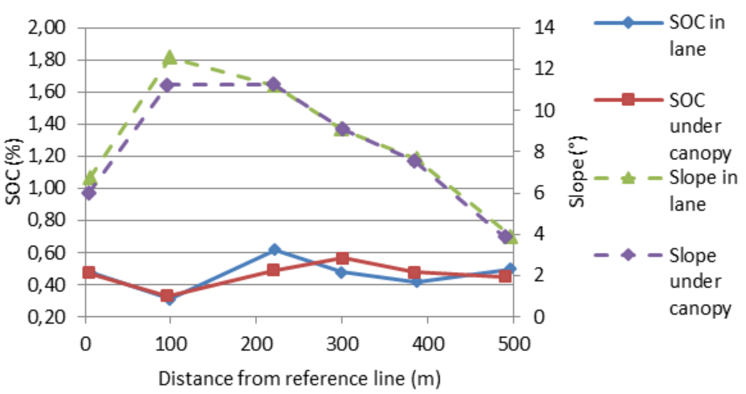
SOC variability in transect 2 (0-15cm), Matasanos



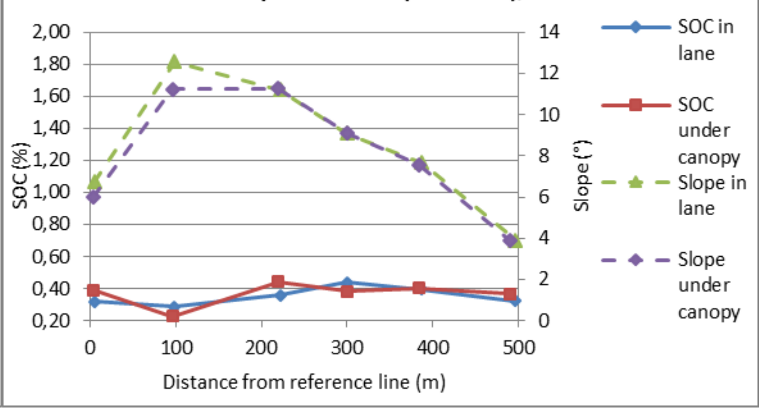
SOC variability in transect 2 (15-30cm), Matasanos

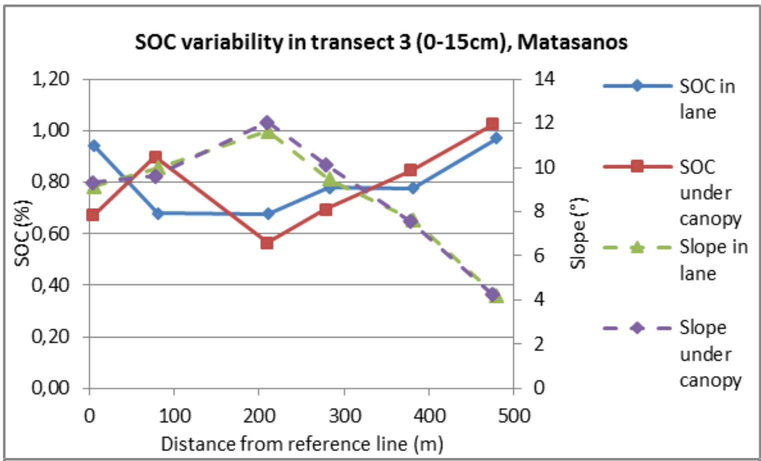


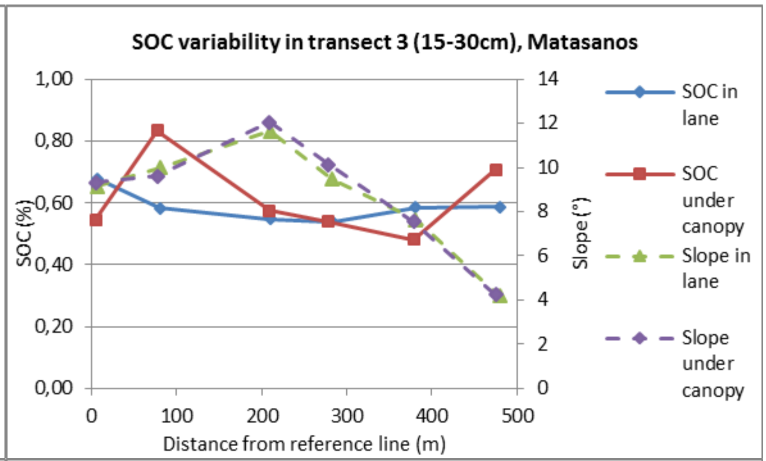
SOC variability in transect 2 (30-60cm), Matasanos

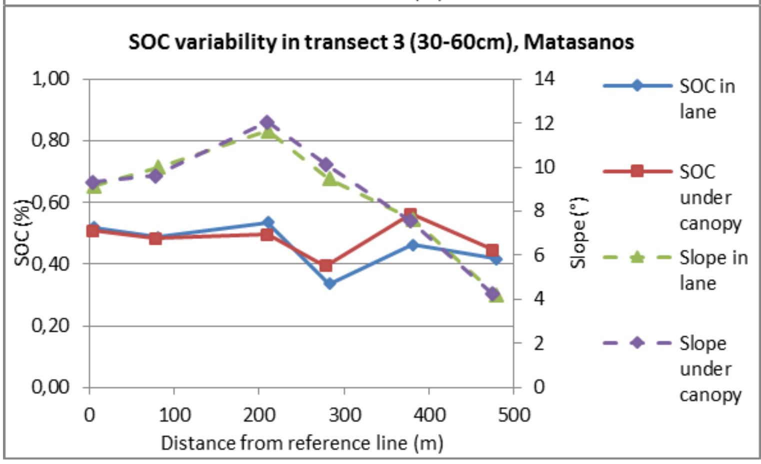


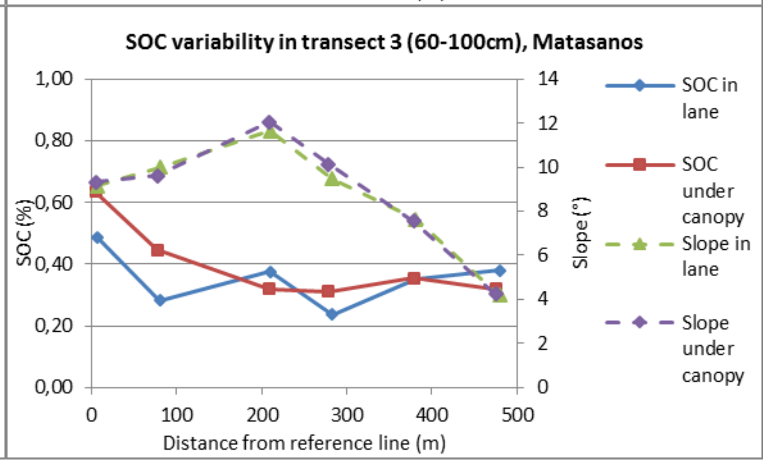
SOC variability in transect 2 (60-100cm), Matasanos

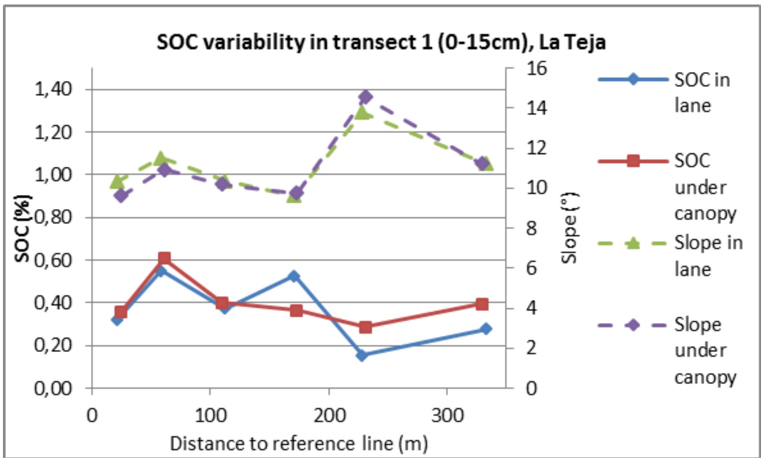


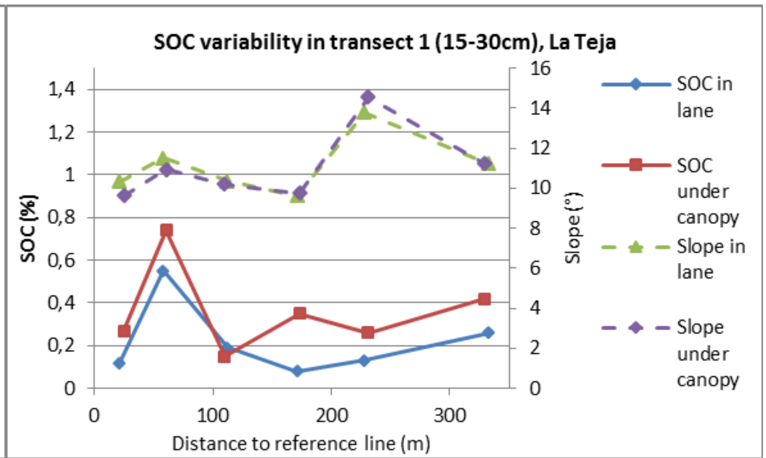

SOC variability in transect 3 (0-15cm), Matasanos
SOC (%)
Slope (°)
Distance from reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

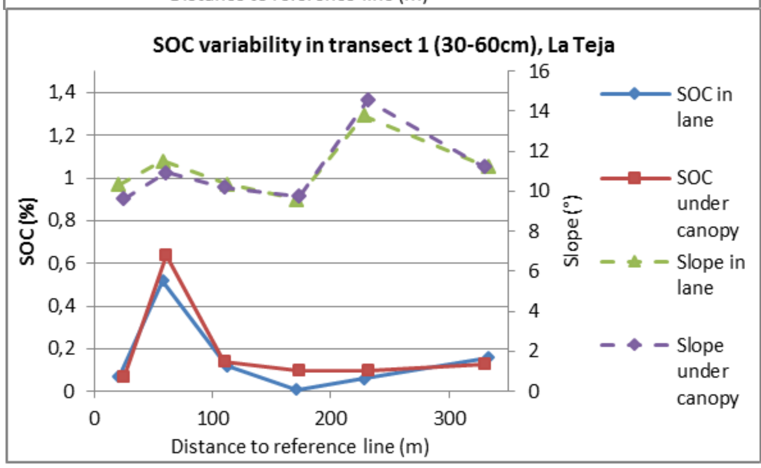

SOC variability in transect 3 (15-30cm), Matasanos
SOC (%)
Slope (°)
Distance from reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

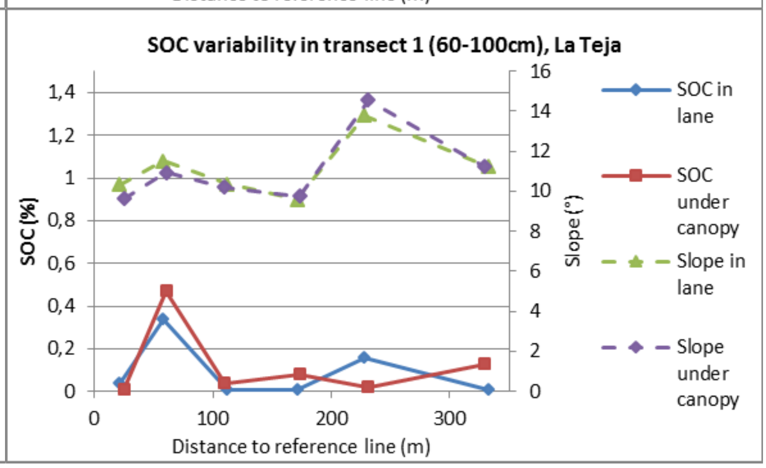

SOC variability in transect 3 (30-60cm), Matasanos
SOC (%)
Slope (°)
Distance from reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

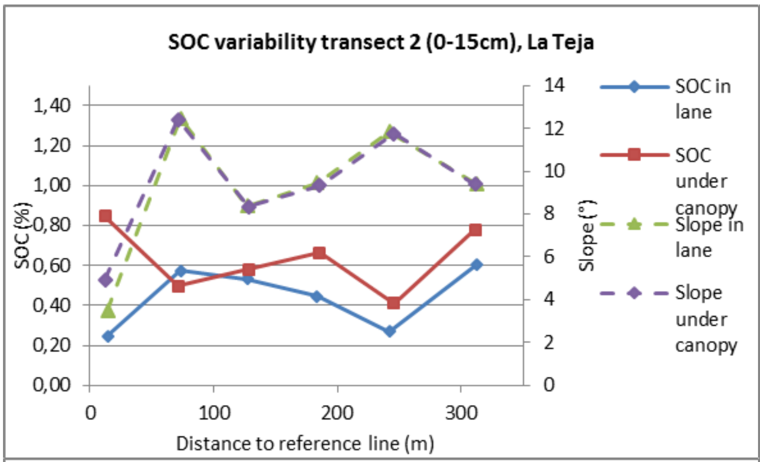

SOC variability in transect 3 (60-100cm), Matasanos
SOC (%)
Slope (°)
Distance from reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

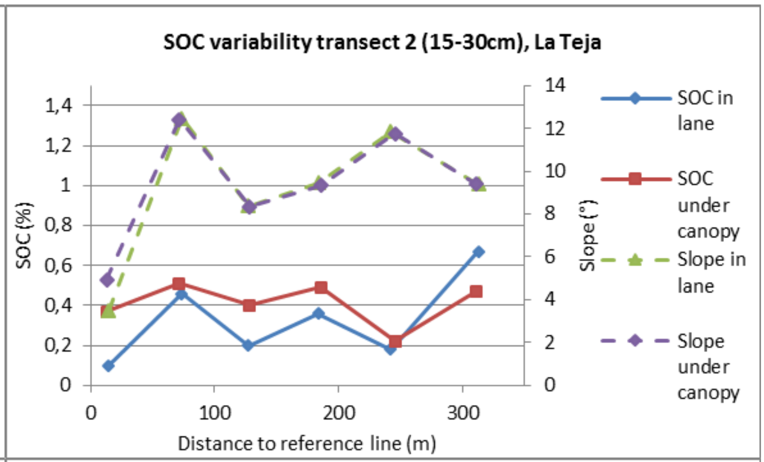

SOC variability in transect 1 (0-15cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

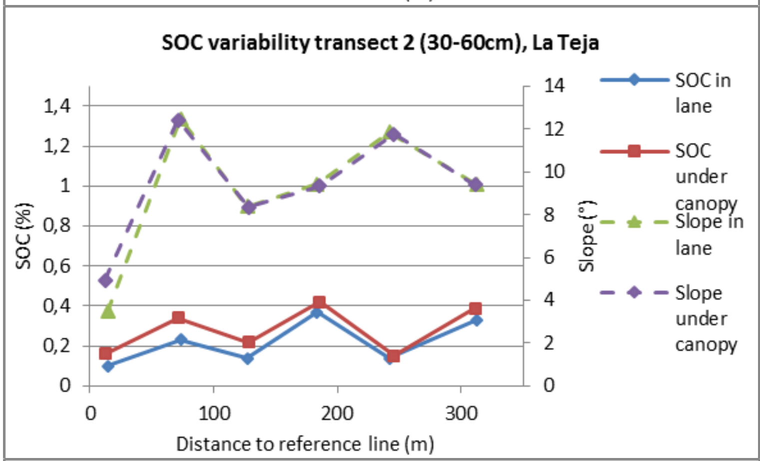

SOC variability in transect 1 (15-30cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

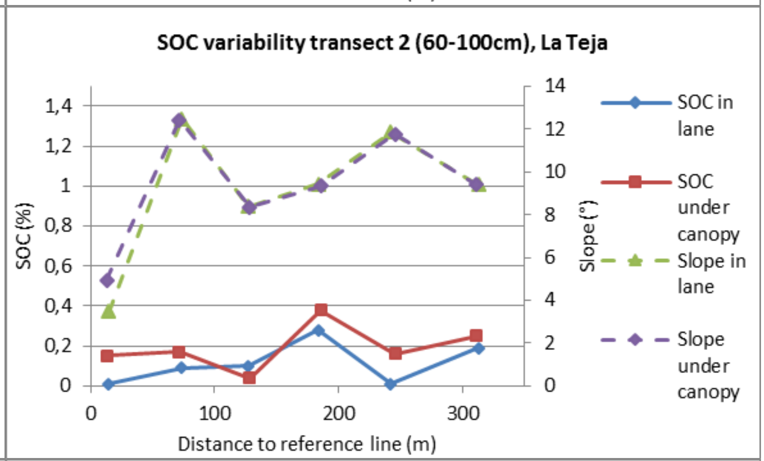

SOC variability in transect 1 (30-60cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

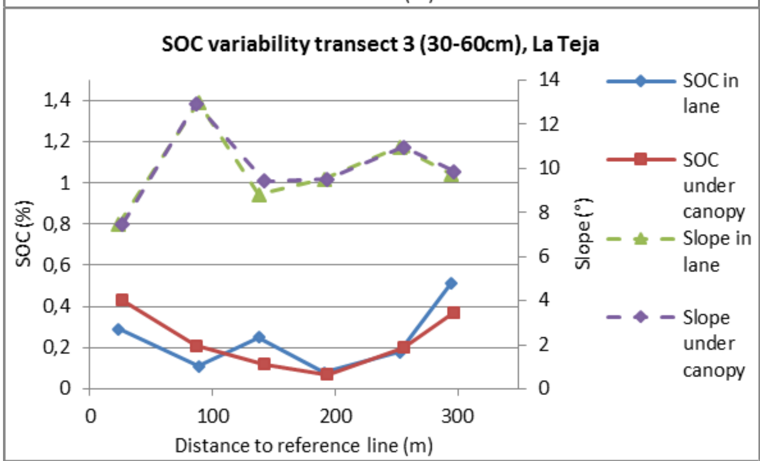

SOC variability in transect 1 (60-100cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

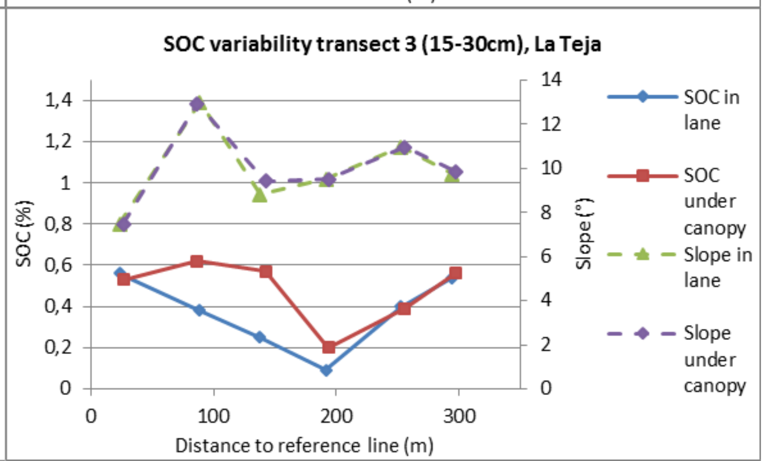

SOC variability transect 2 (0-15cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

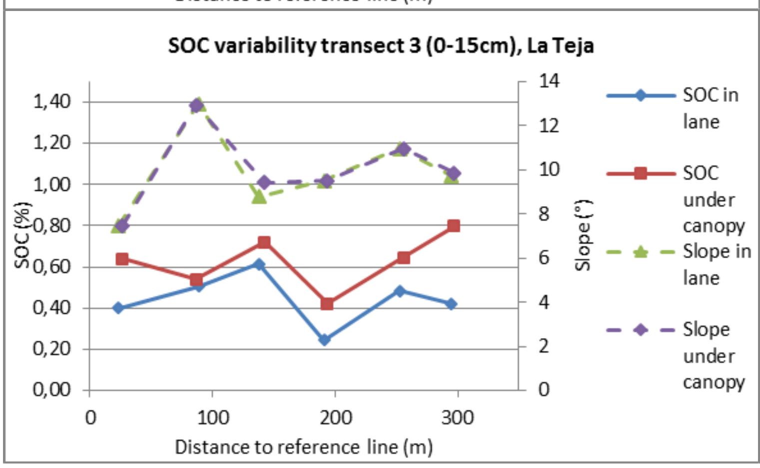

SOC variability transect 2 (15-30cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

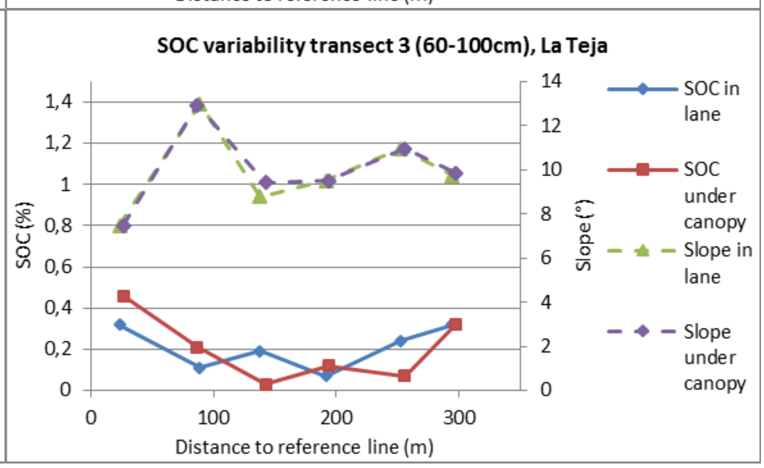

SOC variability transect 2 (30-60cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

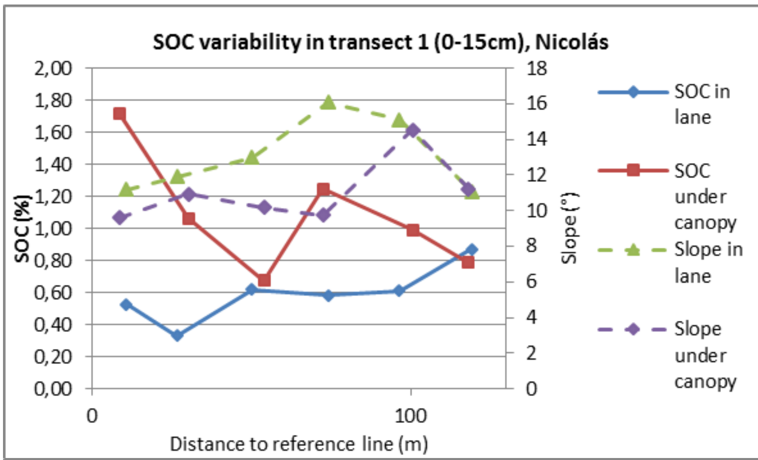

SOC variability transect 2 (60-100cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

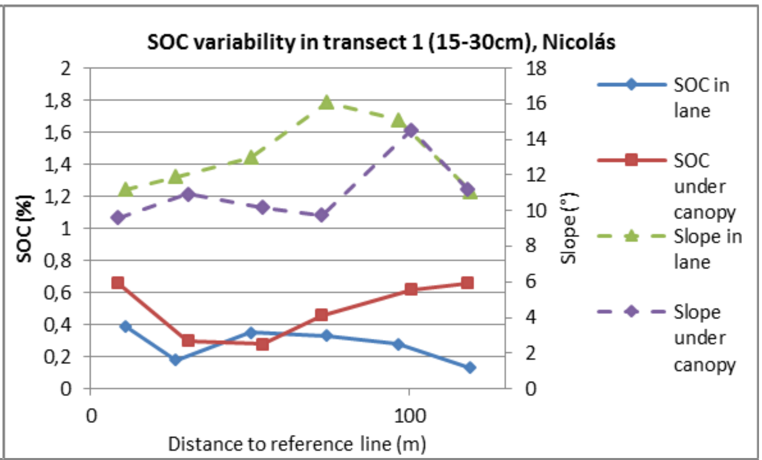

SOC variability transect 3 (30-60cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

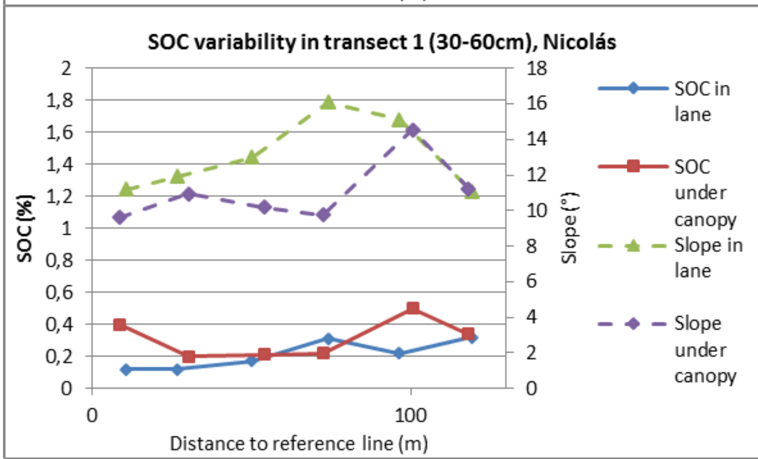

SOC variability transect 3 (15-30cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

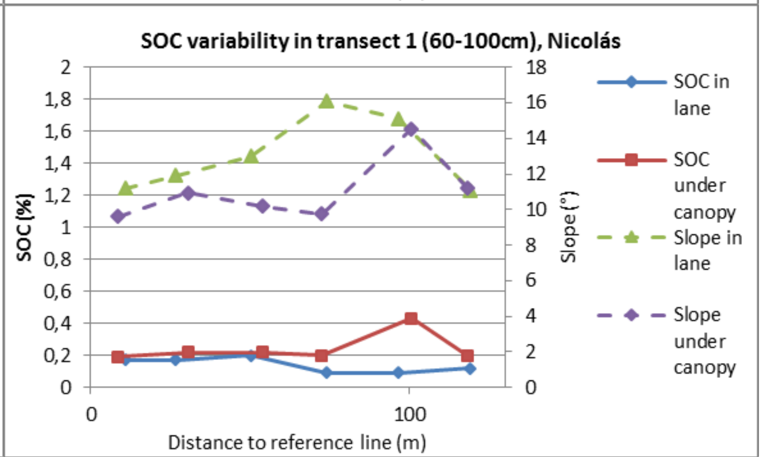

SOC variability transect 3 (0-15cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

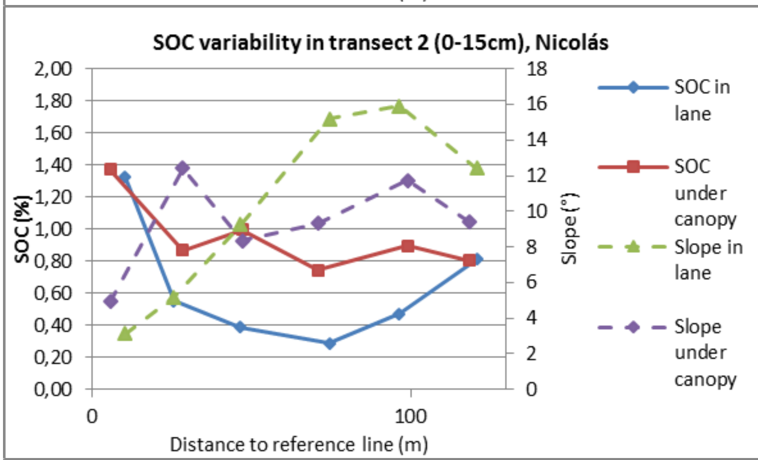

SOC variability transect 3 (60-100cm), La Teja
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

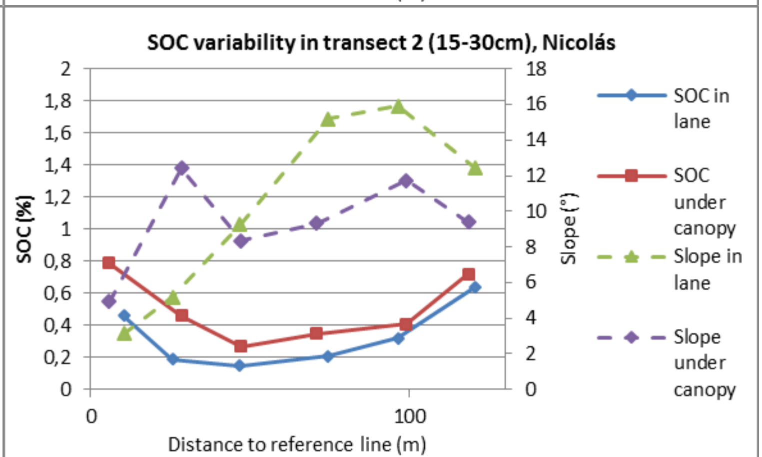

SOC variability in transect 1 (0-15cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

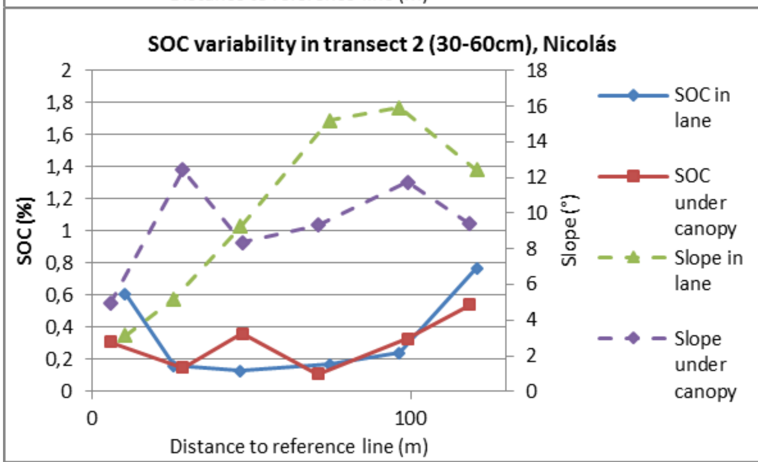

SOC variability in transect 1 (15-30cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

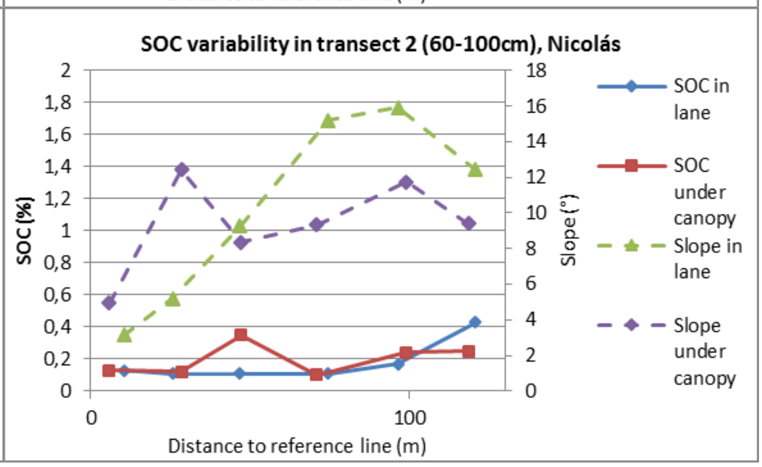

SOC variability in transect 1 (30-60cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

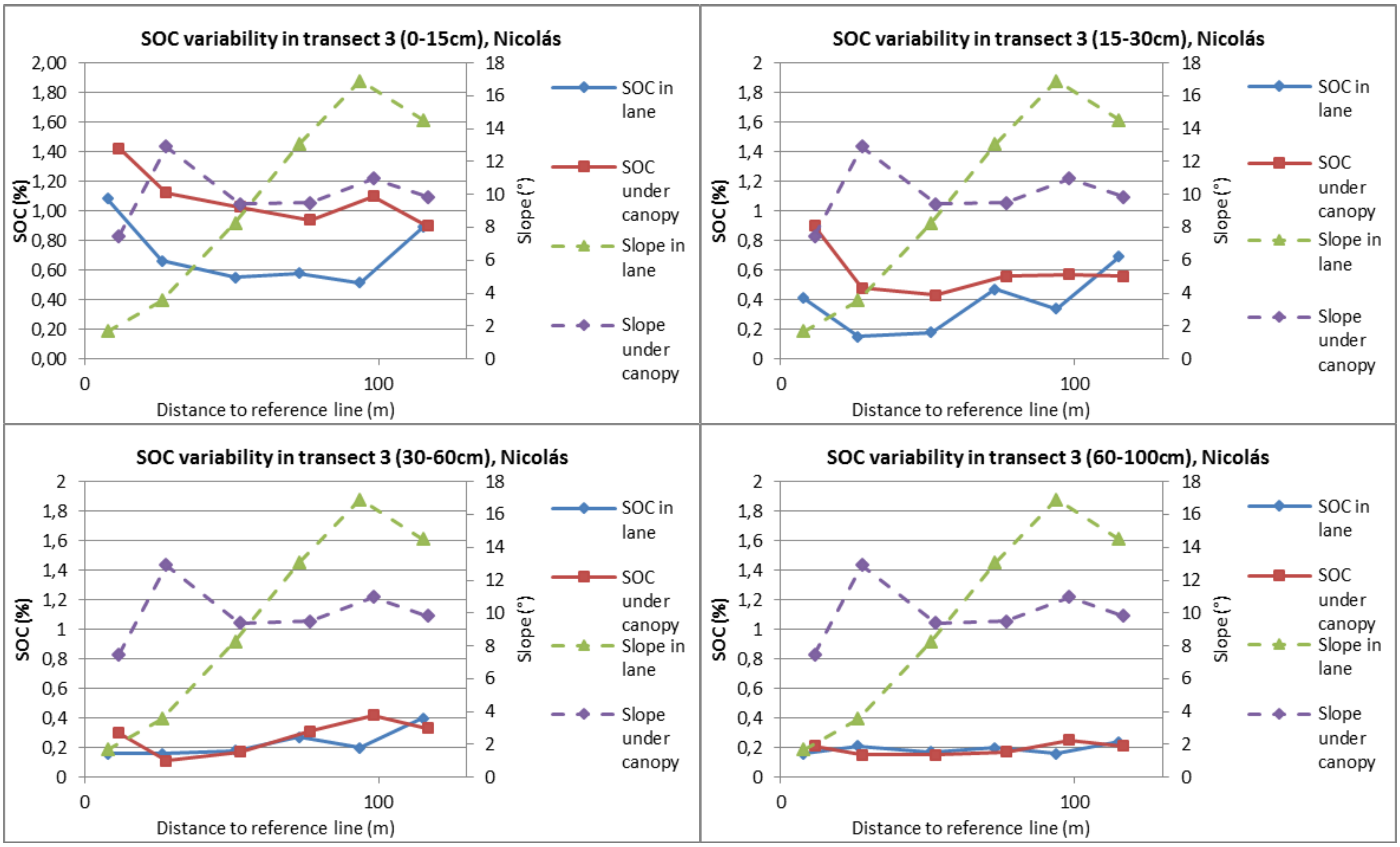

SOC variability in transect 1 (60-100cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy


SOC variability in transect 2 (0-15cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy


SOC variability in transect 2 (15-30cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

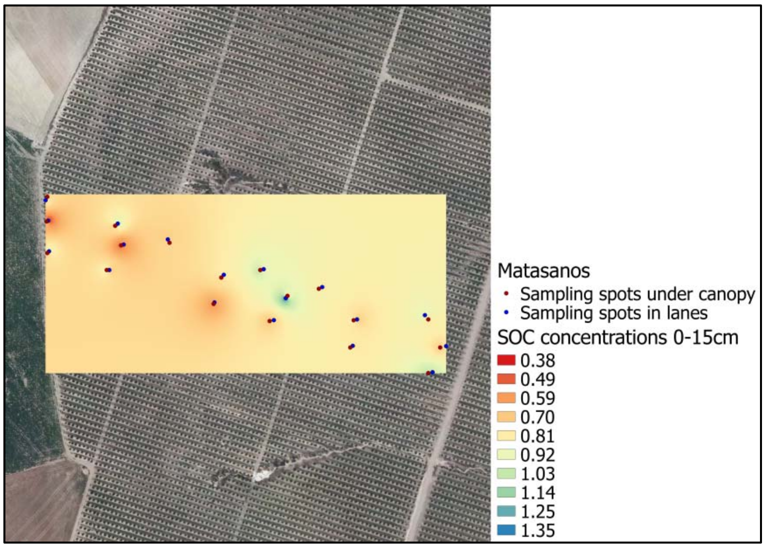

SOC variability in transect 2 (30-60cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

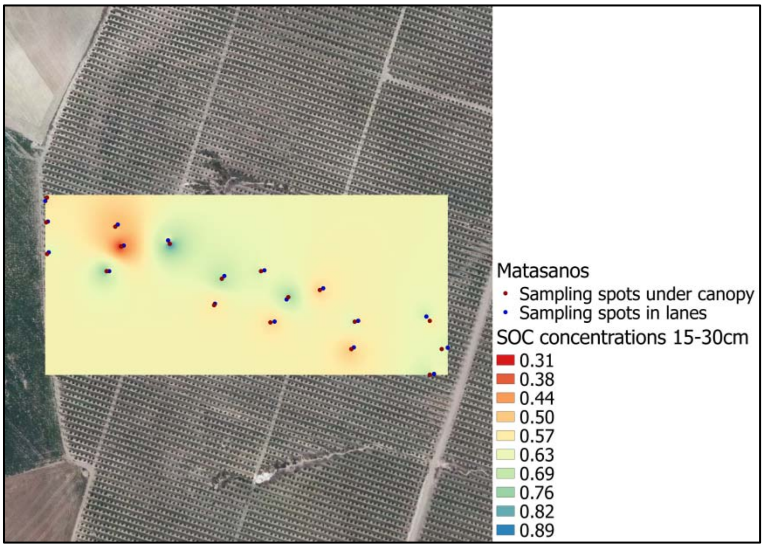

SOC variability in transect 2 (60-100cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

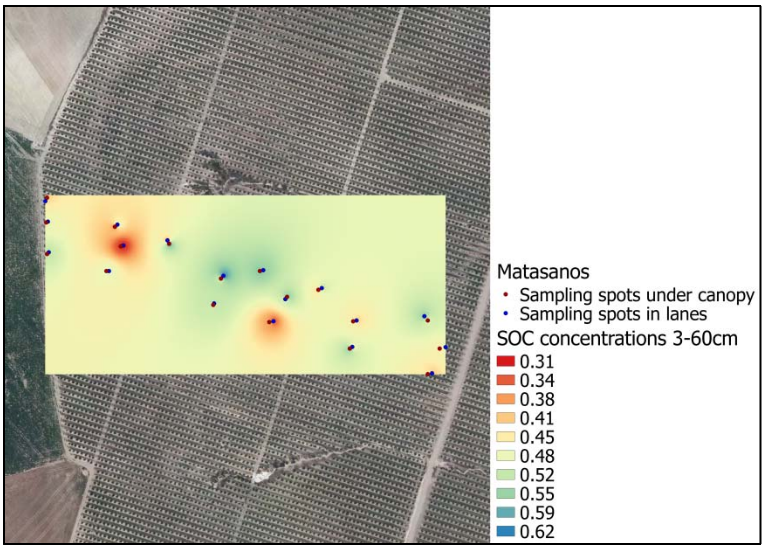

SOC variability in transect 3 (0-15cm), Nicolás
SOC variability in transect 3 (15-30cm), Nicolás
SOC variability in transect 3 (30-60cm), Nicolás
SOC variability in transect 3 (60-100cm), Nicolás
SOC (%)
Slope (°)
Distance to reference line (m)
SOC in lane
SOC under canopy
Slope in lane
Slope under canopy

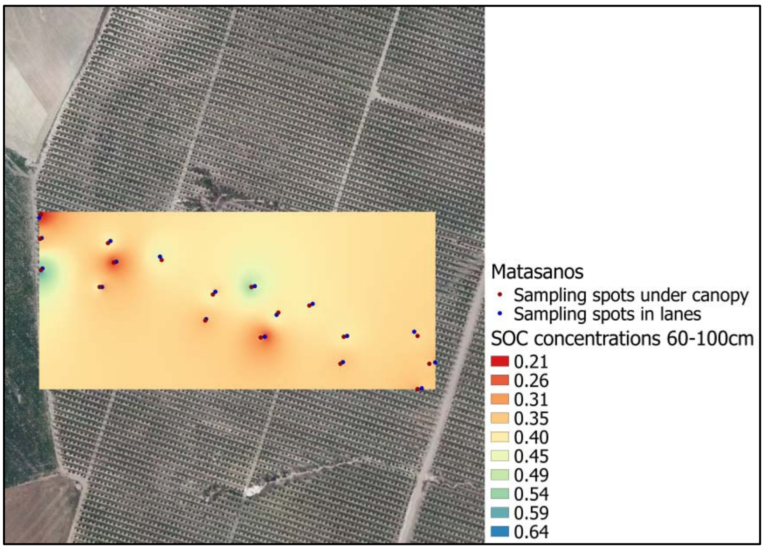
Appendix 5: SOC distribution in each soil layer

Matasanos

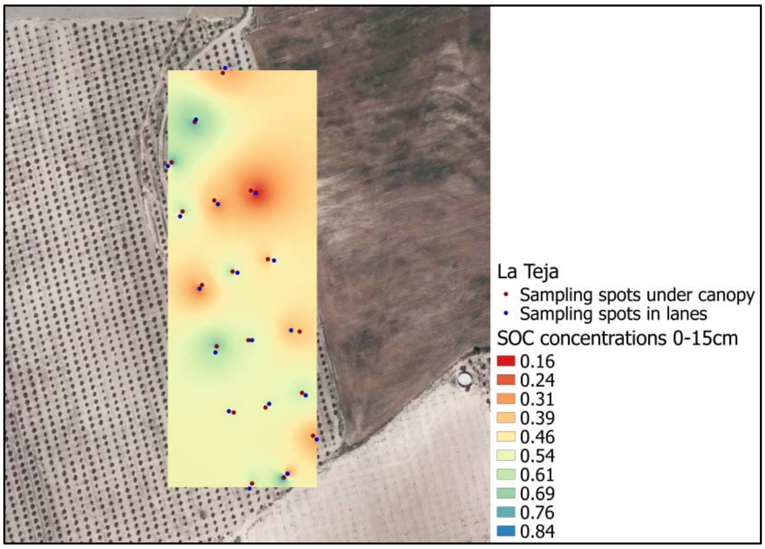


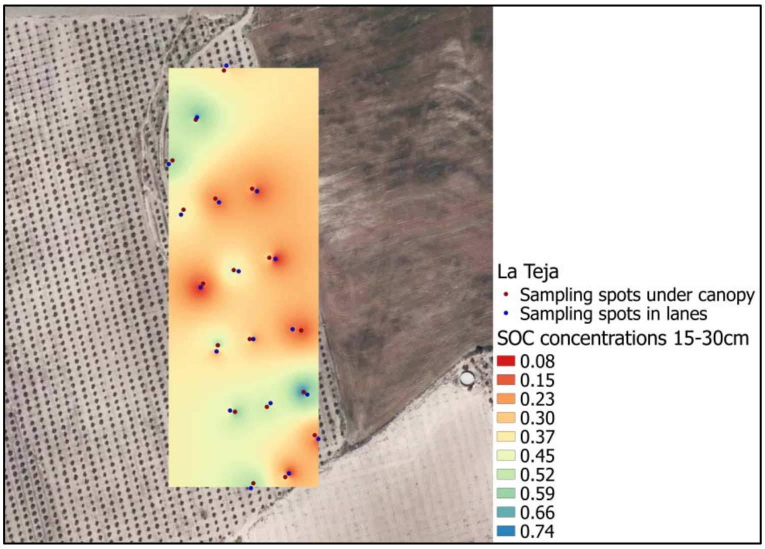


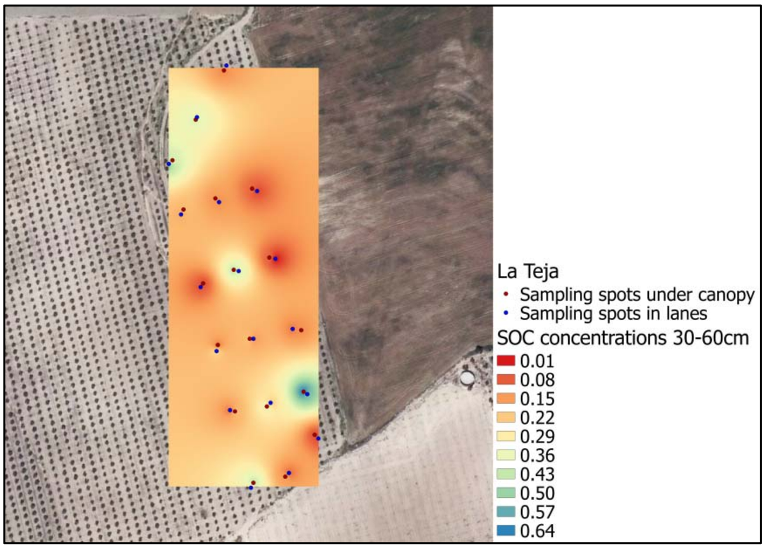


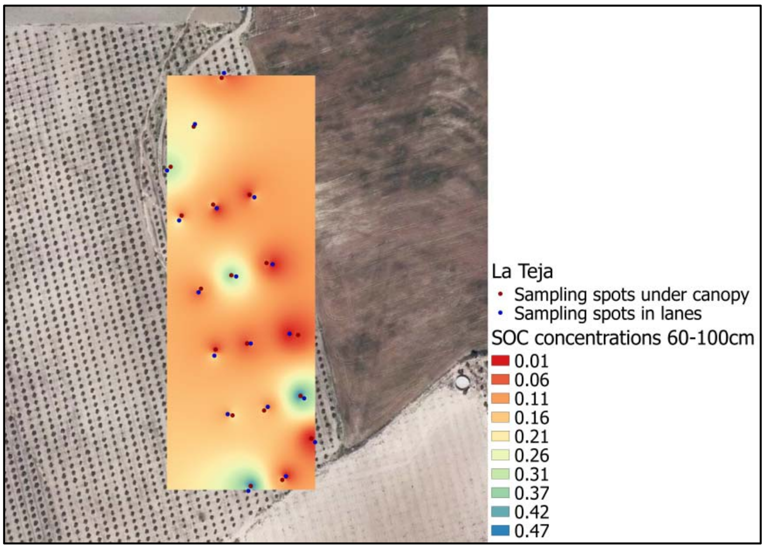


La Teja

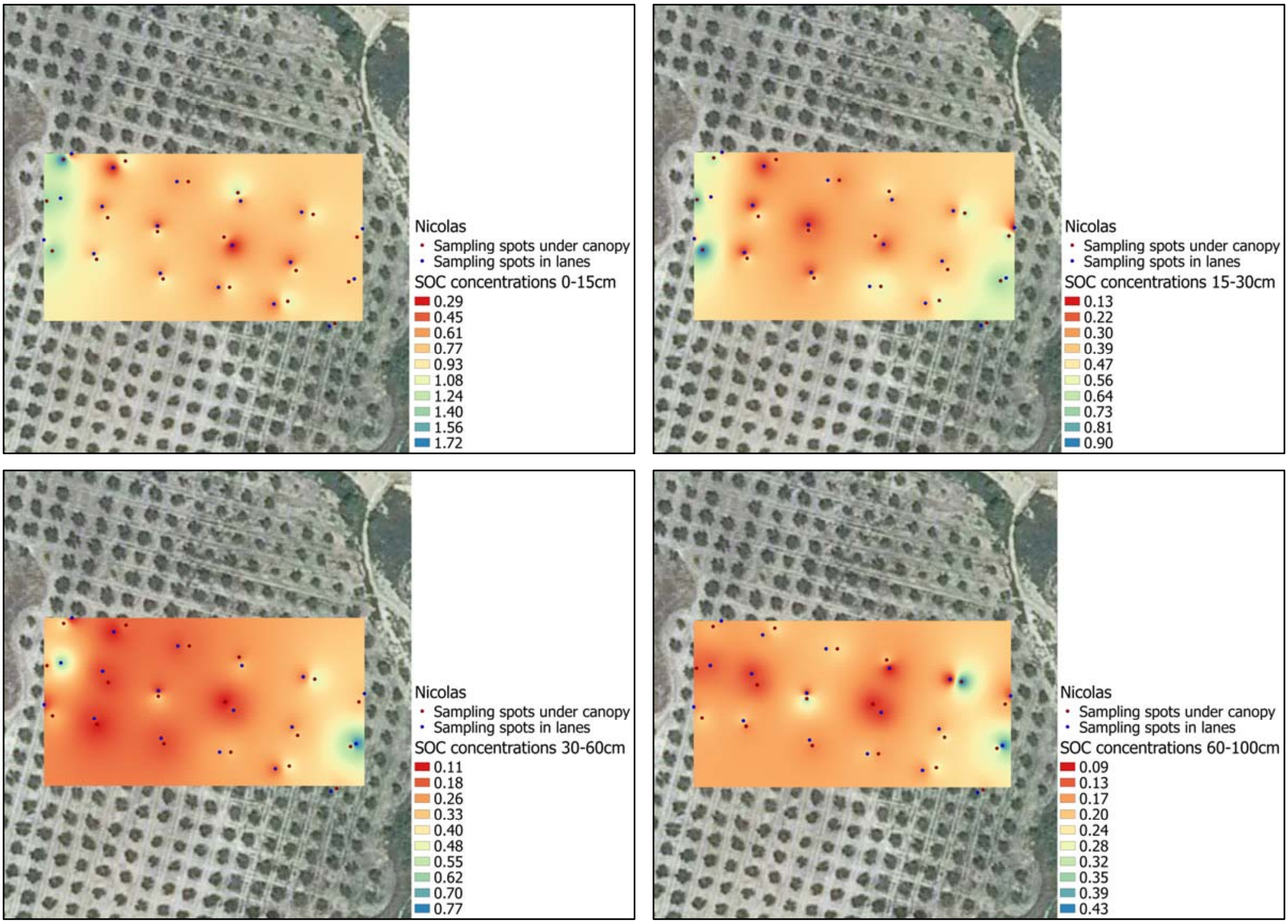

La Teja
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 0-15cm
0.16
0.24
0.31
0.39
0.46
0.54
0.61
0.69
0.76
0.84


La Teja
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 15-30cm
0.08
0.15
0.23
0.30
0.37
0.45
0.52
0.59
0.66
0.74


La Teja
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 30-60cm
0.01
0.08
0.15
0.22
0.29
0.36
0.43
0.50
0.57
0.64


La Teja
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 60-100cm
0.01
0.06
0.11
0.16
0.21
0.26
0.31
0.37
0.42
0.47

Nicolás



Nicolas
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 0-15cm
0.29
0.45
0.61
0.77
0.93
1.08
1.24
1.40
1.56
1.72
Nicolas
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 15-30cm
0.13
0.22
0.30
0.39
0.47
0.56
0.64
0.73
0.81
0.90
Nicolas
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 30-60cm
0.11
0.18
0.26
0.33
0.40
0.48
0.55
0.62
0.70
0.77
Nicolas
Sampling spots under canopy
Sampling spots in lanes
SOC concentrations 60-100cm
0.09
0.13
0.17
0.20
0.24
0.28
0.32
0.35
0.39
0.43

Appendix 6: Canopy cover calculations

Matasanos						
Tree	1	2	3	4	5	6
Trunk perimeter (cm)	44	46	45	40	44	48
Trunk radius (TR) (cm)	7,0	7,3	7,2	6,4	7,0	7,6
Transect 1 (cm)	87	127	122	68	118	107
Transect 2 (cm)	111	97	109	143	15	132
Transect 3 (cm)	159	123	176	109	170	84
Transect 4 (cm)	98	74	83	53	131	157
Average of transects (AT) (cm)	113,75	105,25	122,5	93,25	108,5	120
Total radius (TR + AT) (cm)	120,8	112,6	129,7	99,6	115,5	127,6
Average radius	118					
Average canopy area (cm2)	43465,3					
Average canopy area (m2)	4,3					

La Teja						
Tree	1	2	3	4	5	6
Trunk perimeter (cm)	46	47	51	56	56	53
Trunk radius (TR) (cm)	7,3	7,5	8,1	8,9	8,9	8,4
Transect 1 (cm)	114	118	164	179	219	192
Transect 2 (cm)	95	133	69	99	166	148
Transect 3 (cm)	92	113	122	118	126	154
Transect 4 (cm)	125	154	192	132	112	190
Average of transects (AT) (cm)	106,5	129,5	136,75	132	155,75	171
Total radius (TR + AT) (cm)	113,8	137,0	144,9	140,9	164,7	179,4
Average radius	147					
Average canopy area (cm2)	67683,5					
Average canopy area (m2)	6,8					

Nicolas						
Tree	1	2	3	4	5	6
Trunk perimeter (cm)	130	128	114	92	89	107
Trunk radius (TR) (cm)	20,7	20,4	18,1	14,6	14,2	17,0
Transect 1 (cm)	220	228	266	226	171	239
Transect 2 (cm)	227	237	195	139	207	216
Transect 3 (cm)	187	146	194	171	98	231
Transect 4 (cm)	251	114	123	72	222	240
Average of transects (AT) (cm)	221,25	181,25	194,5	152	174,5	231,5
Total radius (TR + AT) (cm)	241,9	201,6	212,6	166,6	188,7	248,5
Average radius	210					
Average canopy area (cm2)	138553,5					
Average canopy area (m2)	13,9					

Appendix 7: Total organic carbon calculations

TOC per layer (t/ha) = (%OC/100 * bulk density (g/cm3) * soil layer (cm)) * 100

Matasanos Measuring spot	Layer	Bulk density (g/cm3)	SOC content (%)	Soil layer (cm)	TOC per layer(g/cm3)	TOC per layer(g/cm2)	TOC (kg/m2)	TOC (t/ha)	TOC sum layers	TOC sum layers (kg/m2)	TOC sum layers (t/ha)
Lane 1	1 (0-15)	**0,86**	0,83	15	0,0071	0,11	1,07	10,71	0,47	4,71	47,14
	2 (15-30)	**1,18**	0,55	15	0,0065	0,10	0,98	9,77			
	3 (30-60)	**1,15**	0,45	30	0,0051	0,15	1,54	15,41			
	4 (60-100)	**1,19**	0,24	40	0,0028	0,11	1,12	11,25			
Lane 2	1 (0-15)	**0,93**	1,01	15	0,0095	0,14	1,42	14,22	0,61	6,08	60,80
	2 (15-30)	**1,17**	0,48	15	0,0057	0,09	0,85	8,51			
	3 (30-60)	**1,10**	0,50	30	0,0055	0,17	1,65	16,51			
	4 (60-100)	**1,31**	0,41	40	0,0054	0,22	2,16	21,56			
Lane 3	1 (0-15)	**1,03**	0,72	15	0,0074	0,11	1,11	11,09	0,62	6,23	62,34
	2 (15-30)	**1,33**	0,59	15	0,0079	0,12	1,18	11,78			
	3 (30-60)	**1,20**	0,40	30	0,0048	0,15	1,45	14,54			
	4 (60-100)	**1,37**	0,46	40	0,0062	0,25	2,49	24,94			
Lane 4	1 (0-15)	**1,08**	0,86	15	0,0093	0,14	1,39	13,89	0,66	6,62	66,16
	2 (15-30)	**1,17**	0,58	15	0,0068	0,10	1,01	10,13			
	3 (30-60)	**1,23**	0,55	30	0,0067	0,20	2,02	20,17			
	4 (60-100)	**1,26**	0,44	40	0,0055	0,22	2,20	21,97			
Lane 5	1 (0-15)	**0,98**	0,81	15	0,0080	0,12	1,20	11,96	0,58	5,83	58,34
	2 (15-30)	**1,07**	0,57	15	0,0062	0,09	0,92	9,23			
	3 (30-60)	**1,14**	0,52	30	0,0060	0,18	1,79	17,90			
	4 (60-100)	**1,26**	0,38	40	0,0048	0,19	1,92	19,24			
Lane 6	1 (0-15)	**0,94**	0,95	15	0,0089	0,13	1,33	13,35	0,64	6,42	64,17
	2 (15-30)	**1,11**	0,68	15	0,0076	0,11	1,13	11,33			
	3 (30-60)	**1,22**	0,55	30	0,0068	0,20	2,03	20,26			
	4 (60-100)	**1,29**	0,37	40	0,0048	0,19	1,92	19,24			
Lane 7	1 (0-15)	**0,86**	0,33	15	0,0028	0,04	0,42	4,24	0,46	4,58	45,80
	2 (15-30)	**1,18**	0,56	15	0,0066	0,10	0,99	9,92			
	3 (30-60)	**1,15**	0,48	30	0,0055	0,17	1,66	16,56			
	4 (60-100)	**1,19**	0,32	40	0,0038	0,15	1,51	15,07			
Lane 8	1 (0-15)	**0,93**	0,63	15	0,0059	0,09	0,89	8,88	0,42	4,23	42,32
	2 (15-30)	**1,17**	0,46	15	0,0053	0,08	0,80	8,01			
	3 (30-60)	**1,10**	0,31	30	0,0035	0,10	1,04	10,37			
	4 (60-100)	**1,31**	0,29	40	0,0038	0,15	1,50	15,05			
Lane 9	1 (0-15)	**1,03**	0,86	15	0,0089	0,13	1,33	13,35	0,69	6,86	68,59
	2 (15-30)	**1,33**	0,67	15	0,0089	0,13	1,33	13,34			
	3 (30-60)	**1,20**	0,62	30	0,0074	0,22	2,22	22,18			
	4 (60-100)	**1,37**	0,36	40	0,0049	0,20	1,97	19,72			
Lane 10	1 (0-15)	**1,08**	1,37	15	0,0147	0,22	2,21	22,09	0,73	7,31	73,15
	2 (15-30)	**1,17**	0,65	15	0,0076	0,11	1,14	11,36			
	3 (30-60)	**1,23**	0,48	30	0,0059	0,18	1,77	17,66			
	4 (60-100)	**1,26**	0,44	40	0,0055	0,22	2,20	22,04			

Lane 11	1 (0-15)	**0,98**	0,70	15	0,0069	0,10	1,04	10,39	0,53	5,31	53,12
	2 (15-30)	**1,07**	0,52	15	0,0056	0,08	0,84	8,39			
	3 (30-60)	**1,14**	0,42	30	0,0048	0,14	1,44	14,36			
	4 (60-100)	**1,26**	0,40	40	0,0050	0,20	2,00	19,98			
Lane 12	1 (0-15)	**0,94**	0,82	15	0,0077	0,12	1,16	11,55	0,58	5,76	57,55
	2 (15-30)	**1,11**	0,66	15	0,0073	0,11	1,09	10,93			
	3 (30-60)	**1,22**	0,50	30	0,0061	0,18	1,83	18,29			
	4 (60-100)	**1,29**	0,33	40	0,0042	0,17	1,68	16,78			
Lane 13	1 (0-15)	**0,86**	0,94	15	0,0081	0,12	1,21	12,09	0,65	6,51	65,11
	2 (15-30)	**1,18**	0,68	15	0,0080	0,12	1,20	11,96			
	3 (30-60)	**1,15**	0,52	30	0,0060	0,18	1,79	17,95			
	4 (60-100)	**1,19**	0,49	40	0,0058	0,23	2,31	23,12			
Lane 14	1 (0-15)	**0,93**	0,68	15	0,0063	0,10	0,95	9,52	0,51	5,07	50,72
	2 (15-30)	**1,17**	0,58	15	0,0068	0,10	1,02	10,24			
	3 (30-60)	**1,10**	0,49	30	0,0054	0,16	1,61	16,13			
	4 (60-100)	**1,31**	0,28	40	0,0037	0,15	1,48	14,83			
Lane 15	1 (0-15)	**1,03**	0,68	15	0,0070	0,10	1,05	10,47	0,61	6,12	61,18
	2 (15-30)	**1,33**	0,55	15	0,0073	0,11	1,10	10,96			
	3 (30-60)	**1,20**	0,53	30	0,0064	0,19	1,92	19,22			
	4 (60-100)	**1,37**	0,37	40	0,0051	0,21	2,05	20,54			
Lane 16	1 (0-15)	**1,08**	0,78	15	0,0084	0,13	1,26	12,62	0,46	4,64	46,44
	2 (15-30)	**1,17**	0,54	15	0,0063	0,09	0,95	9,48			
	3 (30-60)	**1,23**	0,34	30	0,0041	0,12	1,24	12,44			
	4 (60-100)	**1,26**	0,24	40	0,0030	0,12	1,19	11,89			
Lane 17	1 (0-15)	**0,98**	0,78	15	0,0076	0,11	1,15	11,46	0,55	5,46	54,56
	2 (15-30)	**1,07**	0,58	15	0,0063	0,09	0,94	9,40			
	3 (30-60)	**1,14**	0,46	30	0,0053	0,16	1,59	15,90			
	4 (60-100)	**1,26**	0,35	40	0,0045	0,18	1,78	17,80			
Lane 18	1 (0-15)	**0,94**	0,97	15	0,0091	0,14	1,36	13,65	0,58	5,84	58,38
	2 (15-30)	**1,11**	0,59	15	0,0065	0,10	0,98	9,79			
	3 (30-60)	**1,22**	0,42	30	0,0051	0,15	1,53	15,35			
	4 (60-100)	**1,29**	0,38	40	0,0049	0,20	1,96	19,60			
Under canopy 1	1 (0-15)	**0,79**	0,75	15	0,0059	0,09	0,89	8,88	0,43	4,30	43,00
	2 (15-30)	**1,30**	0,56	15	0,0073	0,11	1,09	10,91			
	3 (30-60)	**1,07**	0,42	30	0,0044	0,13	1,33	13,34			
	4 (60-100)	**1,19**	0,21	40	0,0025	0,10	0,99	9,86			
Under canopy 2	1 (0-15)	**0,85**	0,69	15	0,0059	0,09	0,88	8,84	0,47	4,75	47,49
	2 (15-30)	**1,14**	0,51	15	0,0058	0,09	0,87	8,73			
	3 (30-60)	**1,14**	0,37	30	0,0043	0,13	1,29	12,86			
	4 (60-100)	**1,05**	0,40	40	0,0043	0,17	1,71	17,05			

Under canopy 3	1 (0-15)	**0,83**	0,76	15	0,0063	0,09	0,95	9,50	0,68	6,83	68,30
	2 (15-30)	**1,24**	0,89	15	0,0111	0,17	1,67	16,68			
	3 (30-60)	**1,28**	0,59	30	0,0076	0,23	2,27	22,74			
	4 (60-100)	**1,23**	0,39	40	0,0048	0,19	1,94	19,38			
Under canopy 4	1 (0-15)	**0,78**	1,05	15	0,0082	0,12	1,22	12,25	0,72	7,17	71,72
	2 (15-30)	**1,22**	0,69	15	0,0084	0,13	1,26	12,64			
	3 (30-60)	**1,18**	0,56	30	0,0065	0,20	1,96	19,65			
	4 (60-100)	**1,22**	0,56	40	0,0068	0,27	2,72	27,19			
Under canopy 5	1 (0-15)	**0,66**	0,87	15	0,0057	0,09	0,86	8,57	0,55	5,50	55,02
	2 (15-30)	**1,13**	0,51	15	0,0058	0,09	0,87	8,73			
	3 (30-60)	**1,25**	0,43	30	0,0054	0,16	1,62	16,23			
	4 (60-100)	**1,24**	0,43	40	0,0054	0,21	2,15	21,49			
Under canopy 6	1 (0-15)	**0,74**	0,80	15	0,0059	0,09	0,89	8,89	0,54	5,44	54,39
	2 (15-30)	**1,20**	0,57	15	0,0068	0,10	1,03	10,25			
	3 (30-60)	**1,16**	0,49	30	0,0057	0,17	1,70	17,04			
	4 (60-100)	**1,19**	0,38	40	0,0046	0,18	1,82	18,20			
Under canopy 7	1 (0-15)	**0,79**	0,84	15	0,0066	0,10	0,99	9,90	0,56	5,55	55,55
	2 (15-30)	**1,30**	0,60	15	0,0078	0,12	1,18	11,75			
	3 (30-60)	**1,07**	0,48	30	0,0051	0,15	1,52	15,24			
	4 (60-100)	**1,19**	0,39	40	0,0047	0,19	1,86	18,65			
Under canopy 8	1 (0-15)	**0,85**	0,52	15	0,0044	0,07	0,66	6,59	0,33	3,28	32,79
	2 (15-30)	**1,14**	0,31	15	0,0035	0,05	0,52	5,21			
	3 (30-60)	**1,14**	0,33	30	0,0038	0,11	1,13	11,35			
	4 (60-100)	**1,05**	0,23	40	0,0024	0,10	0,96	9,64			
Under canopy 9	1 (0-15)	**0,83**	0,75	15	0,0063	0,09	0,94	9,40	0,64	6,36	63,62
	2 (15-30)	**1,24**	0,73	15	0,0090	0,14	1,36	13,55			
	3 (30-60)	**1,28**	0,49	30	0,0063	0,19	1,88	18,79			
	4 (60-100)	**1,23**	0,44	40	0,0055	0,22	2,19	21,88			
Under canopy 10	1 (0-15)	**0,78**	0,73	15	0,0056	0,08	0,84	8,44	0,61	6,12	61,24
	2 (15-30)	**1,22**	0,77	15	0,0093	0,14	1,40	14,02			
	3 (30-60)	**1,18**	0,57	30	0,0067	0,20	2,00	20,03			
	4 (60-100)	**1,22**	0,38	40	0,0047	0,19	1,88	18,76			
Under canopy 11	1 (0-15)	**0,66**	0,85	15	0,0056	0,08	0,84	8,43	0,58	5,84	58,45
	2 (15-30)	**1,13**	0,70	15	0,0080	0,12	1,20	11,97			
	3 (30-60)	**1,25**	0,48	30	0,0060	0,18	1,80	17,99			
	4 (60-100)	**1,24**	0,40	40	0,0050	0,20	2,01	20,07			
Under canopy 12	1 (0-15)	**0,74**	0,72	15	0,0053	0,08	0,79	7,93	0,52	5,24	52,41
	2 (15-30)	**1,20**	0,63	15	0,0075	0,11	1,13	11,30			
	3 (30-60)	**1,16**	0,45	30	0,0052	0,16	1,57	15,73			
	4 (60-100)	**1,19**	0,37	40	0,0044	0,17	1,74	17,45			

Under canopy 13	1 (0-15)	**0,79**	0,67	15	0,0053	0,08	0,79	7,95	0,65	6,50	65,04
	2 (15-30)	**1,30**	0,55	15	0,0071	0,11	1,06	10,59			
	3 (30-60)	**1,07**	0,51	30	0,0054	0,16	1,63	16,26			
	4 (60-100)	**1,19**	0,64	40	0,0076	0,30	3,02	30,23			
Under canopy 14	1 (0-15)	**0,85**	0,90	15	0,0077	0,11	1,15	11,49	0,61	6,12	61,18
	2 (15-30)	**1,14**	0,83	15	0,0095	0,14	1,43	14,25			
	3 (30-60)	**1,14**	0,48	30	0,0055	0,17	1,66	16,58			
	4 (60-100)	**1,05**	0,45	40	0,0047	0,19	1,88	18,85			
Under canopy 15	1 (0-15)	**0,83**	0,57	15	0,0047	0,07	0,71	7,05	0,53	5,26	52,55
	2 (15-30)	**1,24**	0,57	15	0,0071	0,11	1,07	10,71			
	3 (30-60)	**1,28**	0,50	30	0,0063	0,19	1,90	19,04			
	4 (60-100)	**1,23**	0,32	40	0,0039	0,16	1,58	15,75			
Under canopy 16	1 (0-15)	**0,78**	0,69	15	0,0054	0,08	0,81	8,06	0,47	4,70	47,04
	2 (15-30)	**1,22**	0,54	15	0,0066	0,10	0,99	9,87			
	3 (30-60)	**1,18**	0,39	30	0,0046	0,14	1,39	13,92			
	4 (60-100)	**1,22**	0,31	40	0,0038	0,15	1,52	15,19			
Under canopy 17	1 (0-15)	**0,66**	0,84	15	0,0056	0,08	0,83	8,35	0,55	5,53	55,26
	2 (15-30)	**1,13**	0,48	15	0,0054	0,08	0,82	8,17			
	3 (30-60)	**1,25**	0,56	30	0,0070	0,21	2,11	21,06			
	4 (60-100)	**1,24**	0,36	40	0,0044	0,18	1,77	17,69			
Under canopy 18	1 (0-15)	**0,74**	1,03	15	0,0076	0,11	1,14	11,37	0,55	5,49	54,89
	2 (15-30)	**1,20**	0,71	15	0,0085	0,13	1,27	12,72			
	3 (30-60)	**1,16**	0,45	30	0,0052	0,16	1,56	15,55			
	4 (60-100)	**1,19**	0,32	40	0,0038	0,15	1,52	15,25			

La Teja Measuring spot	Layer	Bulk density (g/cm3)	SOC content (%)	Soil layer (cm)	TOC per layer(g/cm3)	TOC per layer (g/cm2)	TOC (kg/m2)	TOC (t/ha)	TOC sum layers	TOC sum layers (kg/m2)	TOC sum layers (t/ha)
Lane 1	1 (0-15)	1,24	0,32	15	0,0040	0,06	0,60	6,01	0,12	1,24	12,42
	2 (15-30)	1,35	0,12	15	0,0016	0,02	0,24	2,42			
	3 (30-60)	1,12	0,07	30	0,0008	0,02	0,24	2,37			
	4 (60-100)	1,09	0,04	40	0,0004	0,02	0,16	1,63			
Lane 2	1 (0-15)	1,26	0,55	15	0,0069	0,10	1,04	10,35	0,55	5,51	55,08
	2 (15-30)	1,30	0,55	15	0,0071	0,11	1,07	10,67			
	3 (30-60)	1,13	0,52	30	0,0059	0,18	1,76	17,58			
	4 (60-100)	1,19	0,34	40	0,0041	0,16	1,65	16,48			
Lane 3	1 (0-15)	1,18	0,37	15	0,0044	0,07	0,66	6,59	0,15	1,54	15,41
	2 (15-30)	1,30	0,19	15	0,0025	0,04	0,37	3,72			
	3 (30-60)	1,33	0,12	30	0,0016	0,05	0,47	4,73			
	4 (60-90)	1,36	0,01	30	0,0001	0,00	0,04	0,36			
Lane 4	1 (0-15)	1,20	0,53	15	0,0063	0,10	0,95	9,52	0,11	1,12	11,21
	2 (15-30)	1,27	0,08	15	0,0010	0,01	0,14	1,44			
	3 (30-52)	1,38	0,01	22	0,0001	0,00	0,03	0,25			
	----	1,30	0,01	0	0,0001	0,00	0,00	0,00			
Lane 5	1 (0-15)	1,22	0,16	15	0,0019	0,03	0,28	2,85	0,16	1,57	15,67
	2 (15-30)	1,22	0,13	15	0,0016	0,02	0,24	2,44			
	3 (30-60)	1,26	0,06	30	0,0008	0,02	0,24	2,38			
	4 (60-100)	1,29	0,16	40	0,0020	0,08	0,80	8,00			
Lane 6	1 (0-15)	1,30	0,28	15	0,0036	0,05	0,54	5,44	0,15	1,52	15,23
	2 (15-30)	1,13	0,26	15	0,0029	0,04	0,44	4,39			
	3 (30-60)	1,02	0,16	30	0,0016	0,05	0,49	4,89			
	4 (60-100)	1,14	0,01	40	0,0001	0,01	0,05	0,52			
Lane 7	1 (0-15)	1,24	0,25	15	0,0031	0,05	0,46	4,58	0,10	1,03	10,30
	2 (15-30)	1,35	0,10	15	0,0013	0,02	0,20	1,97			
	3 (30-60)	1,12	0,10	30	0,0011	0,03	0,34	3,42			
	4 (60-100)	1,09	0,01	40	0,0001	0,00	0,03	0,32			
Lane 8	1 (0-15)	1,26	0,57	15	0,0072	0,11	1,08	10,77	0,30	3,03	30,32
	2 (15-30)	1,30	0,46	15	0,0059	0,09	0,89	8,90			
	3 (30-60)	1,13	0,23	30	0,0026	0,08	0,77	7,69			
	4 (60-87)	1,19	0,09	27	0,0011	0,03	0,30	2,96			
Lane 9	1 (0-15)	1,18	0,53	15	0,0063	0,09	0,94	9,41	0,22	2,18	21,83
	2 (15-30)	1,30	0,20	15	0,0026	0,04	0,39	3,85			
	3 (30-60)	1,33	0,14	30	0,0019	0,06	0,56	5,55			
	4 (60-82)	1,36	0,10	22	0,0014	0,03	0,30	3,02			
Lane 10	1 (0-15)	1,20	0,45	15	0,0054	0,08	0,80	8,05	0,45	4,49	44,93
	2 (15-30)	1,27	0,36	15	0,0045	0,07	0,68	6,79			
	3 (30-60)	1,38	0,37	30	0,0051	0,15	1,54	15,42			
	4 (60-100)	1,30	0,28	40	0,0037	0,15	1,47	14,67			

Lane 11	1 (0-15)	1,22	0,27	15	0,0033	0,05	0,49	4,93	0,14	1,40	13,97
	2 (15-30)	1,22	0,18	15	0,0021	0,03	0,32	3,22			
	3 (30-60)	1,26	0,14	30	0,0018	0,05	0,53	5,28			
	4 (60-100)	1,29	0,01	40	0,0001	0,01	0,05	0,54			
Lane 12	1 (0-15)	1,30	0,61	15	0,0079	0,12	1,18	11,78	0,42	4,20	42,02
	2 (15-30)	1,13	0,67	15	0,0076	0,11	1,13	11,33			
	3 (30-60)	1,02	0,33	30	0,0034	0,10	1,02	10,15			
	4 (60-100)	1,14	0,19	40	0,0022	0,09	0,88	8,76			
Lane 13	1 (0-15)	1,24	0,40	15	0,0050	0,07	0,75	7,46	0,43	4,25	42,50
	2 (15-30)	1,35	0,56	15	0,0075	0,11	1,13	11,32			
	3 (30-60)	1,12	0,29	30	0,0033	0,10	0,99	9,93			
	4 (60-100)	1,09	0,32	40	0,0034	0,14	1,38	13,79			
Lane 14	1 (0-15)	1,26	0,50	15	0,0063	0,10	0,95	9,50	0,26	2,60	26,04
	2 (15-30)	1,30	0,38	15	0,0049	0,07	0,74	7,42			
	3 (30-60)	1,13	0,11	30	0,0013	0,04	0,39	3,86			
	4 (60-100)	1,19	0,11	40	0,0013	0,05	0,53	5,26			
Lane 15	1 (0-15)	1,18	0,61	15	0,0072	0,11	1,08	10,83	0,28	2,79	27,89
	2 (15-30)	1,30	0,25	15	0,0032	0,05	0,49	4,86			
	3 (30-60)	1,33	0,25	30	0,0034	0,10	1,01	10,11			
	4 (60-68)	1,36	0,19	8	0,0026	0,02	0,21	2,09			
Lane 16	1 (0-15)	1,20	0,24	15	0,0029	0,04	0,44	4,40	0,13	1,30	13,04
	2 (15-30)	1,27	0,09	15	0,0012	0,02	0,18	1,81			
	3 (30-60)	1,38	0,08	30	0,0011	0,03	0,33	3,26			
	4 (60-100)	1,30	0,07	40	0,0009	0,04	0,36	3,58			
Lane 17	1 (0-15)	1,22	0,49	15	0,0059	0,09	0,89	8,86	0,26	2,58	25,85
	2 (15-30)	1,22	0,40	15	0,0049	0,07	0,73	7,28			
	3 (30-60)	1,26	0,18	30	0,0022	0,07	0,67	6,66			
	4 (60-70)	1,29	0,24	10	0,0031	0,03	0,31	3,05			
Lane 18	1 (0-15)	1,30	0,42	15	0,0055	0,08	0,82	8,19	0,47	4,75	47,49
	2 (15-30)	1,13	0,54	15	0,0061	0,09	0,92	9,16			
	3 (30-60)	1,02	0,51	30	0,0052	0,16	1,57	15,67			
	4 (60-100)	1,14	0,32	40	0,0036	0,14	1,45	14,47			
Under canopy 1	1 (0-15)	0,96	0,36	15	0,0034	0,05	0,51	5,15	0,14	1,38	13,83
	2 (15-30)	1,33	0,27	15	0,0036	0,05	0,54	5,42			
	3 (30-60)	1,39	0,07	30	0,0010	0,03	0,29	2,89			
	4 (60-90)	1,40	0,01	30	0,0001	0,00	0,04	0,36			
Under canopy 2	1 (0-15)	0,80	0,61	15	0,0048	0,07	0,73	7,27	0,62	6,25	62,46
	2 (15-30)	1,15	0,74	15	0,0085	0,13	1,27	12,73			
	3 (30-60)	1,25	0,64	30	0,0080	0,24	2,39	23,92			
	4 (60-90)	1,30	0,47	30	0,0062	0,19	1,85	18,52			

Under canopy 3	1 (0-15)	0,93	0,40	15	0,0037	0,06	0,56	5,59	0,15	1,54	15,45
	2 (15-30)	1,21	0,15	15	0,0018	0,03	0,27	2,69			
	3 (30-60)	1,35	0,14	30	0,0019	0,06	0,56	5,58			
	4 (60-87)	1,69	0,04	27	0,0006	0,02	0,16	1,60			
Under canopy 4	1 (0-15)	0,98	0,37	15	0,0036	0,05	0,54	5,40	0,18	1,83	18,30
	2 (15-30)	1,04	0,35	15	0,0036	0,05	0,54	5,42			
	3 (30-60)	1,30	0,10	30	0,0013	0,04	0,40	4,01			
	4 (60-94)	1,30	0,08	34	0,0010	0,03	0,35	3,46			
Under canopy 5	1 (0-15)	0,96	0,29	15	0,0028	0,04	0,41	4,14	0,13	1,28	12,85
	2 (15-30)	1,11	0,26	15	0,0028	0,04	0,43	4,25			
	3 (30-60)	1,21	0,10	30	0,0012	0,04	0,36	3,65			
	4 (60-100)	1,18	0,02	40	0,0002	0,01	0,08	0,81			
Under canopy 6	1 (0-15)	0,90	0,40	15	0,0036	0,05	0,53	5,33	0,22	2,25	22,50
	2 (15-30)	1,20	0,42	15	0,0050	0,07	0,75	7,49			
	3 (30-60)	1,27	0,13	30	0,0017	0,05	0,51	5,13			
	4 (60-85)	1,40	0,13	25	0,0018	0,05	0,45	4,54			
Under canopy 7	1 (0-15)	0,96	0,85	15	0,0081	0,12	1,21	12,15	0,34	3,45	34,46
	2 (15-30)	1,33	0,37	15	0,0049	0,07	0,74	7,38			
	3 (30-60)	1,39	0,16	30	0,0023	0,07	0,68	6,78			
	4 (60-100)	1,40	0,15	40	0,0020	0,08	0,82	8,16			
Under canopy 8	1 (0-15)	0,80	0,50	15	0,0040	0,06	0,59	5,94	0,34	3,38	33,75
	2 (15-30)	1,15	0,51	15	0,0058	0,09	0,87	8,70			
	3 (30-60)	1,25	0,34	30	0,0042	0,13	1,27	12,65			
	4 (60-90)	1,30	0,17	30	0,0022	0,06	0,65	6,46			
Under canopy 9	1 (0-15)	0,93	0,58	15	0,0054	0,08	0,81	8,11	0,26	2,64	26,43
	2 (15-30)	1,21	0,40	15	0,0049	0,07	0,73	7,35			
	3 (30-60)	1,35	0,22	30	0,0030	0,09	0,91	9,09			
	4 (60-86)	1,69	0,04	26	0,0007	0,02	0,19	1,88			
Under canopy 10	1 (0-15)	0,98	0,66	15	0,0065	0,10	0,98	9,79	0,50	5,02	50,18
	2 (15-30)	1,04	0,49	15	0,0051	0,08	0,77	7,66			
	3 (30-60)	1,30	0,42	30	0,0055	0,16	1,64	16,39			
	4 (60-93)	1,30	0,38	33	0,0050	0,16	1,63	16,34			
Under canopy 11	1 (0-15)	0,96	0,41	15	0,0040	0,06	0,59	5,93	0,17	1,70	17,00
	2 (15-30)	1,11	0,22	15	0,0024	0,04	0,37	3,67			
	3 (30-60)	1,21	0,15	30	0,0018	0,05	0,54	5,44			
	4 (60-70)	1,18	0,16	10	0,0019	0,02	0,19	1,95			
Under canopy 12	1 (0-15)	0,90	0,78	15	0,0070	0,10	1,05	10,45	0,38	3,80	37,97
	2 (15-30)	1,20	0,47	15	0,0056	0,08	0,84	8,35			
	3 (30-60)	1,27	0,39	30	0,0050	0,15	1,50	15,03			
	4 (60-72)	1,40	0,25	12	0,0034	0,04	0,41	4,14			

Under canopy 13	1 (0-15)	0,96	0,64	15	0,0061	0,09	0,92	9,16	0,57	5,72	57,23
	2 (15-30)	1,33	0,53	15	0,0070	0,11	1,05	10,52			
	3 (30-60)	1,39	0,43	30	0,0060	0,18	1,81	18,05			
	4 (60-90)	1,40	0,46	30	0,0065	0,20	1,95	19,50			
Under canopy 14	1 (0-15)	0,80	0,54	15	0,0043	0,06	0,64	6,43	0,30	3,04	30,42
	2 (15-30)	1,15	0,62	15	0,0071	0,11	1,06	10,60			
	3 (30-60)	1,25	0,21	30	0,0026	0,08	0,79	7,95			
	4 (60-80)	1,30	0,21	20	0,0027	0,05	0,54	5,45			
Under canopy 15	1 (0-15)	0,93	0,72	15	0,0067	0,10	1,00	10,01	0,27	2,70	27,00
	2 (15-30)	1,21	0,57	15	0,0070	0,10	1,04	10,43			
	3 (30-60)	1,35	0,12	30	0,0016	0,05	0,48	4,82			
	4 (60-100)	1,69	0,03	40	0,0004	0,02	0,17	1,73			
Under canopy 16	1 (0-15)	0,98	0,42	15	0,0041	0,06	0,62	6,21	0,17	1,74	17,44
	2 (15-30)	1,04	0,20	15	0,0021	0,03	0,32	3,20			
	3 (30-60)	1,30	0,07	30	0,0009	0,03	0,28	2,76			
	4 (60-94)	1,30	0,12	34	0,0016	0,05	0,53	5,27			
Under canopy 17	1 (0-15)	0,96	0,64	15	0,0062	0,09	0,93	9,29	0,25	2,54	25,39
	2 (15-30)	1,11	0,39	15	0,0043	0,06	0,65	6,45			
	3 (30-60)	1,21	0,20	30	0,0025	0,07	0,74	7,41			
	4 (60-88)	1,18	0,07	28	0,0008	0,02	0,22	2,24			
Under canopy 18	1 (0-15)	0,90	0,80	15	0,0071	0,11	1,07	10,71	0,44	4,39	43,87
	2 (15-30)	1,20	0,56	15	0,0067	0,10	1,01	10,10			
	3 (30-60)	1,27	0,37	30	0,0047	0,14	1,42	14,21			
	4 (60-80)	1,40	0,32	20	0,0044	0,09	0,89	8,85			

Nicolás		Bulk density	SOC content	Soil layer	TOC per	TOC	TOC	TOC sum	TOC sum layers	TOC sum layers
Measuring spot	Layer	(g/cm3)	(%)	(cm)	layer	(kg/m2)	(t/ha)	layers	(kg/m2)	(t/ha)
Lane 1	1 (0-15)	0,97	0,53	15	0,08	0,77	7,66	0,25	2,49	24,92
	2 (15-30)	0,99	0,39	15	0,06	0,57	5,73			
	3 (30-60)	1,08	0,12	30	0,04	0,40	4,02			
	4 (60-100)	1,09	0,17	40	0,08	0,75	7,52			
Lane 2	1 (0-15)	0,97	0,33	15	0,05	0,48	4,84	0,20	1,96	19,61
	2 (15-30)	1,11	0,18	15	0,03	0,30	2,97			
	3 (30-60)	1,14	0,12	30	0,04	0,41	4,10			
	4 (60-100)	1,13	0,17	40	0,08	0,77	7,70			
Lane 3	1 (0-15)	0,97	0,62	15	0,09	0,90	9,00	0,27	2,74	27,40
	2 (15-30)	1,12	0,35	15	0,06	0,59	5,88			
	3 (30-60)	0,97	0,17	30	0,05	0,49	4,94			
	4 (60-100)	0,94	0,20	40	0,08	0,76	7,58			
Lane 4	1 (0-15)	0,95	0,58	15	0,08	0,83	8,32	0,30	3,04	30,43
	2 (15-30)	1,33	0,33	15	0,07	0,66	6,63			
	3 (30-60)	1,19	0,31	30	0,11	1,11	11,12			
	4 (60-100)	1,15	0,09	40	0,04	0,44	4,36			
Lane 5	1 (0-15)	0,96	0,61	15	0,09	0,88	8,78	0,27	2,72	27,22
	2 (15-30)	1,26	0,28	15	0,05	0,52	5,25			
	3 (30-60)	1,25	0,22	30	0,08	0,83	8,32			
	4 (60-100)	1,34	0,09	40	0,05	0,49	4,87			
Lane 6	1 (0-15)	0,82	0,87	15	0,11	1,07	10,65	0,30	2,99	29,92
	2 (15-30)	1,08	0,13	15	0,02	0,21	2,08			
	3 (30-60)	1,20	0,32	30	0,11	1,15	11,48			
	4 (60-100)	1,17	0,12	40	0,06	0,57	5,71			
Lane 7	1 (0-15)	0,97	1,32	15	0,19	1,92	19,24	0,52	5,16	51,64
	2 (15-30)	0,99	0,46	15	0,07	0,68	6,75			
	3 (30-60)	1,08	0,61	30	0,20	1,98	19,79			
	4 (60-100)	1,09	0,13	40	0,06	0,59	5,85			
Lane 8	1 (0-15)	0,97	0,55	15	0,08	0,81	8,08	0,22	2,15	21,51
	2 (15-30)	1,11	0,19	15	0,03	0,31	3,11			
	3 (30-60)	1,14	0,16	30	0,05	0,54	5,44			
	4 (60-100)	1,13	0,11	40	0,05	0,49	4,88			
Lane 9	1 (0-15)	0,97	0,39	15	0,06	0,56	5,64	0,16	1,61	16,14
	2 (15-30)	1,12	0,15	15	0,02	0,25	2,45			
	3 (30-60)	0,97	0,13	30	0,04	0,38	3,82			
	4 (60-100)	0,94	0,11	40	0,04	0,42	4,23			
Lane 10	1 (0-15)	0,95	0,29	15	0,04	0,41	4,11	0,19	1,94	19,35
	2 (15-30)	1,33	0,21	15	0,04	0,42	4,24			
	3 (30-60)	1,19	0,17	30	0,06	0,59	5,94			
	4 (60-100)	1,15	0,11	40	0,05	0,51	5,06			

Lane 11	1 (0-15)	0,96	0,47	15	0,07	0,68	6,81	0,31	3,08	30,83
	2 (15-30)	1,26	0,32	15	0,06	0,60	5,98			
	3 (30-60)	1,25	0,24	30	0,09	0,90	9,00			
	4 (60-100)	1,34	0,17	40	0,09	0,90	9,04			
Lane 12	1 (0-15)	0,82	0,81	15	0,10	0,99	9,94	0,68	6,80	68,00
	2 (15-30)	1,08	0,64	15	0,10	1,04	10,42			
	3 (30-60)	1,20	0,77	30	0,28	2,76	27,59			
	4 (60-100)	1,17	0,43	40	0,20	2,00	20,05			
Lane 13	1 (0-15)	0,97	1,08	15	0,16	1,58	15,76	0,34	3,41	34,09
	2 (15-30)	0,99	0,41	15	0,06	0,61	6,14			
	3 (30-60)	1,08	0,16	30	0,05	0,53	5,28			
	4 (60-100)	1,09	0,16	40	0,07	0,69	6,90			
Lane 14	1 (0-15)	0,97	0,66	15	0,10	0,97	9,67	0,27	2,70	27,01
	2 (15-30)	1,11	0,15	15	0,03	0,25	2,52			
	3 (30-60)	1,14	0,16	30	0,05	0,54	5,37			
	4 (60-100)	1,13	0,21	40	0,09	0,95	9,45			
Lane 15	1 (0-15)	0,97	0,55	15	0,08	0,80	8,00	0,23	2,26	22,65
	2 (15-30)	1,12	0,18	15	0,03	0,31	3,09			
	3 (30-60)	0,97	0,18	30	0,05	0,52	5,16			
	4 (60-100)	0,94	0,17	40	0,06	0,64	6,39			
Lane 16	1 (0-15)	0,95	0,58	15	0,08	0,83	8,31	0,37	3,67	36,72
	2 (15-30)	1,33	0,47	15	0,09	0,94	9,45			
	3 (30-60)	1,19	0,27	30	0,10	0,98	9,78			
	4 (60-100)	1,15	0,20	40	0,09	0,92	9,18			
Lane 17	1 (0-15)	0,96	0,51	15	0,07	0,74	7,39	0,30	3,02	30,16
	2 (15-30)	1,26	0,34	15	0,06	0,65	6,45			
	3 (30-60)	1,25	0,20	30	0,08	0,76	7,56			
	4 (60-100)	1,34	0,16	40	0,09	0,88	8,76			
Lane 18	1 (0-15)	0,82	0,89	15	0,11	1,09	10,91	0,48	4,78	47,78
	2 (15-30)	1,08	0,69	15	0,11	1,12	11,16			
	3 (30-60)	1,20	0,40	30	0,15	1,45	14,52			
	4 (60-100)	1,17	0,24	40	0,11	1,12	11,19			
Under canopy 1	1 (0-15)	0,68	1,72	15	0,18	1,75	17,52	0,45	4,45	44,55
	2 (15-30)	0,94	0,66	15	0,09	0,93	9,32			
	3 (30-60)	0,81	0,40	30	0,10	0,97	9,66			
	4 (60-100)	1,03	0,19	40	0,08	0,80	8,04			
Under canopy 2	1 (0-15)	0,74	1,06	15	0,12	1,18	11,83	0,33	3,31	33,12
	2 (15-30)	1,11	0,30	15	0,05	0,49	4,91			
	3 (30-60)	1,00	0,20	30	0,06	0,59	5,94			
	4 (60-100)	1,17	0,22	40	0,10	1,04	10,44			

Under canopy 3	1 (0-15)	0,79	0,68	15	0,0054	0,08	0,81	8,07	0,27	2,74	27,40
	2 (15-30)	1,05	0,28	15	0,0029	0,04	0,44	4,36			
	3 (30-60)	0,93	0,21	30	0,0020	0,06	0,59	5,91			
	4 (60-95)	1,02	0,22	40	0,0023	0,09	0,91	9,05			
Under canopy 4	1 (0-15)	0,78	1,25	15	0,0098	0,15	1,47	14,67	0,38	3,82	38,21
	2 (15-30)	0,95	0,46	15	0,0044	0,07	0,66	6,60			
	3 (30-60)	1,05	0,22	30	0,0023	0,07	0,68	6,77			
	4 (60-100)	1,25	0,20	40	0,0025	0,10	1,02	10,18			
Under canopy 5	1 (0-15)	0,86	0,99	15	0,0085	0,13	1,28	12,77	0,60	5,98	59,81
	2 (15-30)	1,10	0,62	15	0,0068	0,10	1,02	10,22			
	3 (30-60)	1,07	0,50	30	0,0054	0,16	1,62	16,16			
	4 (60-100)	1,20	0,43	40	0,0052	0,21	2,07	20,67			
Under canopy 6	1 (0-15)	0,79	0,79	15	0,0063	0,09	0,94	9,38	0,41	4,13	41,30
	2 (15-30)	1,00	0,66	15	0,0066	0,10	0,99	9,87			
	3 (30-60)	1,14	0,34	30	0,0038	0,11	1,14	11,43			
	4 (60-100)	1,30	0,20	40	0,0027	0,11	1,06	10,61			
Under canopy 7	1 (0-15)	0,68	1,37	15	0,0093	0,14	1,40	13,99	0,38	3,79	37,89
	2 (15-30)	0,94	0,79	15	0,0074	0,11	1,11	11,06			
	3 (30-60)	0,81	0,31	30	0,0025	0,07	0,75	7,46			
	4 (60-100)	1,03	0,13	40	0,0013	0,05	0,54	5,38			
Under canopy 8	1 (0-15)	0,74	0,87	15	0,0064	0,10	0,96	9,64	0,28	2,76	27,65
	2 (15-30)	1,11	0,46	15	0,0051	0,08	0,77	7,65			
	3 (30-60)	1,00	0,15	30	0,0015	0,05	0,46	4,61			
	4 (60-100)	1,17	0,12	40	0,0014	0,06	0,57	5,75			
Under canopy 9	1 (0-15)	0,79	1,00	15	0,0079	0,12	1,19	11,87	0,40	4,04	40,36
	2 (15-30)	1,05	0,27	15	0,0028	0,04	0,42	4,20			
	3 (30-60)	0,93	0,36	30	0,0033	0,10	1,00	9,95			
	4 (60-100)	1,02	0,35	40	0,0036	0,14	1,43	14,34			
Under canopy 10	1 (0-15)	0,78	0,74	15	0,0058	0,09	0,87	8,74	0,22	2,24	22,45
	2 (15-30)	0,95	0,35	15	0,0034	0,05	0,50	5,03			
	3 (30-60)	1,05	0,11	30	0,0012	0,04	0,35	3,52			
	4 (60-100)	1,25	0,10	40	0,0013	0,05	0,52	5,16			
Under canopy 11	1 (0-15)	0,86	0,90	15	0,0077	0,12	1,16	11,56	0,40	4,02	40,16
	2 (15-30)	1,10	0,41	15	0,0045	0,07	0,68	6,77			
	3 (30-60)	1,07	0,33	30	0,0035	0,10	1,05	10,48			
	4 (60-100)	1,20	0,24	40	0,0028	0,11	1,14	11,35			
Under canopy 12	1 (0-15)	0,79	0,80	15	0,0064	0,10	0,96	9,60	0,52	5,17	51,65
	2 (15-30)	1,00	0,72	15	0,0072	0,11	1,08	10,78			
	3 (30-60)	1,14	0,54	30	0,0061	0,18	1,83	18,31			
	4 (60-100)	1,30	0,25	40	0,0032	0,13	1,30	12,97			

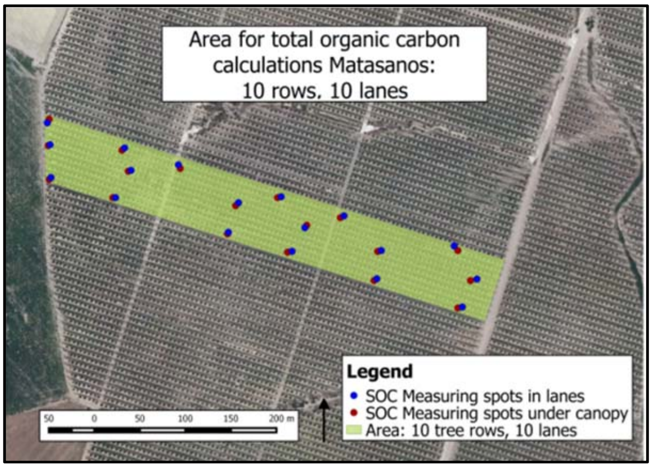
Under canopy 13	1 (0-15)	0,68	1,42	15	0,0097	0,14	1,45	14,50	0,43	4,31	43,07
	2 (15-30)	0,94	0,90	15	0,0084	0,13	1,26	12,59			
	3 (30-60)	0,81	0,30	30	0,0024	0,07	0,73	7,33			
	4 (60-100)	1,03	0,21	40	0,0022	0,09	0,87	8,65			
Under canopy 14	1 (0-15)	0,74	1,12	15	0,0083	0,12	1,25	12,50	0,31	3,09	30,94
	2 (15-30)	1,11	0,48	15	0,0054	0,08	0,80	8,03			
	3 (30-60)	1,00	0,11	30	0,0011	0,03	0,34	3,37			
	4 (60-100)	1,17	0,15	40	0,0018	0,07	0,70	7,04			
Under canopy 15	1 (0-15)	0,79	1,03	15	0,0082	0,12	1,23	12,27	0,30	2,97	29,66
	2 (15-30)	1,05	0,43	15	0,0045	0,07	0,67	6,72			
	3 (30-60)	0,93	0,17	30	0,0015	0,05	0,46	4,59			
	4 (60-100)	1,02	0,15	40	0,0015	0,06	0,61	6,08			
Under canopy 16	1 (0-15)	0,78	0,94	15	0,0074	0,11	1,10	11,03	0,37	3,73	37,25
	2 (15-30)	0,95	0,56	15	0,0053	0,08	0,80	7,98			
	3 (30-60)	1,05	0,31	30	0,0032	0,10	0,96	9,64			
	4 (60-100)	1,25	0,17	40	0,0021	0,09	0,86	8,59			
Under canopy 17	1 (0-15)	0,86	1,10	15	0,0095	0,14	1,42	14,18	0,49	4,91	49,12
	2 (15-30)	1,10	0,57	15	0,0063	0,09	0,95	9,45			
	3 (30-60)	1,07	0,42	30	0,0045	0,14	1,35	13,52			
	4 (60-100)	1,20	0,25	40	0,0030	0,12	1,20	11,97			
Under canopy 18	1 (0-15)	0,79	0,90	15	0,0071	0,11	1,07	10,70	0,41	4,13	41,34
	2 (15-30)	1,00	0,56	15	0,0056	0,08	0,84	8,37			
	3 (30-60)	1,14	0,33	30	0,0038	0,11	1,13	11,33			
	4 (60-100)	1,30	0,21	40	0,0027	0,11	1,09	10,94			

TOC estimation study area

Matasanos

Lane	TOC (t/ha)	Under canopy	TOC (t/ha)
1	47,14	1	43,00
2	60,80	2	47,49
3	62,34	3	68,30
4	66,16	4	71,72
5	58,34	5	55,02
6	64,17	6	54,39
7	45,80	7	55,55
8	42,32	8	32,79
9	68,59	9	63,62
10	73,15	10	61,24
11	53,12	11	58,45
12	57,55	12	52,41
13	65,11	13	65,04
14	50,72	14	61,18
15	61,18	15	52,55
16	46,44	16	47,04
17	54,56	17	55,26
18	58,38	18	54,89
Total	57,55	Total	55,55

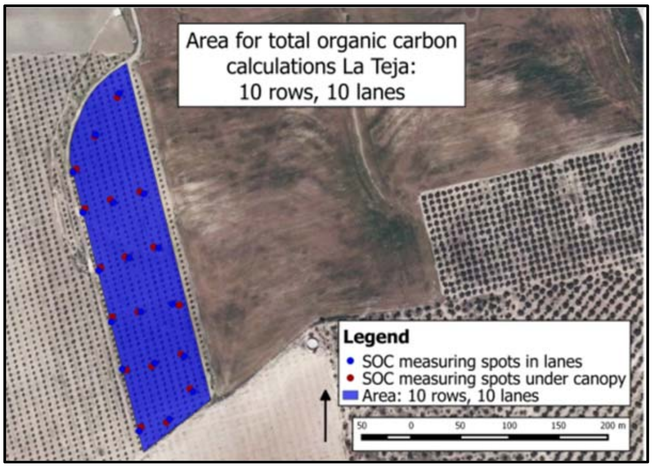
Area: 10 lanes, 10 tree rows	
Total field area (m2)	36000
Number of trees (estimated)	1030
Average canopy area per tree (m2)	4,3
Total canopy cover area (m2)	4477
% canopy cover	12,4
Total lanes area (m2)	31523
Total SOC lanes (t)	181
Total SOC under canopy (t)	25
Total SOC area (t)	**206**
Total SOC (ton/ha)	57,3
No dual behaviour, only lanes: TOC (t)	207,2



La Teja

Lane	TOC (t/ha)	Under canopy	TOC (t/ha)
1	12,42	1	13,83
2	55,08	2	62,46
3	15,41	3	15,45
4	11,21	4	18,30
5	15,67	5	12,85
6	15,23	6	22,50
7	10,30	7	34,46
8	30,32	8	33,75
9	21,83	9	26,43
10	44,93	10	50,18
11	13,97	11	17,00
12	42,02	12	37,97
13	42,50	13	57,23
14	26,04	14	30,42
15	27,89	15	27,00
16	13,04	16	17,44
17	25,85	17	25,39
18	47,49	18	43,87
Total	26,18	Total	30,36

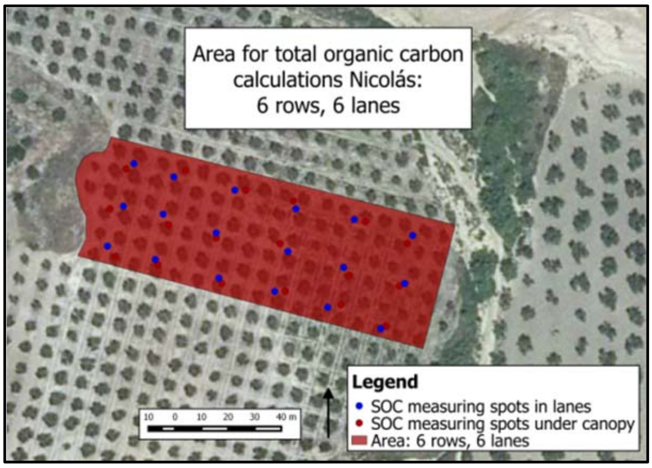
Area: 10 lanes, 10 tree rows	
Total field area (m2)	27520
Number of trees (estimated)	577
Average canopy area per tree (m2)	6,77
Total canopy cover area (m2)	3905
% canopy cover	14,2
Total lanes area (m2)	23615
Total SOC lanes (t)	62
Total SOC under canopy (t)	12
Total SOC area (t)	**74**
Total SOC (ton/ha)	26,8
No dual behaviour, only lanes: TOC (t)	72,0



Nicolás

Lane	TOC (t/ha)	Under canopy	TOC (t/ha)
1	24,92	1	44,55
2	19,61	2	33,12
3	27,40	3	27,40
4	30,43	4	38,21
5	27,22	5	59,81
6	29,92	6	41,30
7	51,64	7	37,89
8	21,51	8	27,65
9	16,14	9	40,36
10	19,35	10	22,45
11	30,83	11	40,16
12	68,00	12	51,65
13	34,09	13	43,07
14	27,01	14	30,94
15	22,65	15	29,66
16	36,72	16	37,25
17	30,16	17	49,12
18	47,78	18	41,34
Total	31,41	Total	38,66

Area: 6 lanes, 6 tree rows	
Total field area (m2)	6496
Number of trees (estimated)	104
Average canopy area per tree (m2)	13,9
Total canopy cover area (m2)	1441
% canopy cover	22,2
Total lanes area (m2)	5055
Total SOC lanes (t)	16
Total SOC under canopy (t)	6
Total SOC area (t)	**21**
Total SOC (ton/ha)	33,0
No dual behaviour, only lanes: TOC (t)	20,4



Appendix 8: ANOVA

Tests of Between-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	SOC (0-15cm)	5,710[a]	29	,197	5,498	,000
	SOC (15-30cm)	2,330[b]	29	,080	3,704	,000
	SOC (30-60cm)	1,879[c]	29	,065	4,255	,000
	SOC (60-100cm)	1,307[d]	29	,045	4,282	,000
	TOC	20488,267[e]	29	706,492	5,345	,000
Intercept	SOC (0-15cm)	23,603	1	23,603	659,090	,000
	SOC (15-30cm)	11,005	1	11,005	507,297	,000
	SOC (30-60cm)	6,047	1	6,047	397,173	,000
	SOC (60-100cm)	2,886	1	2,886	274,138	,000
	TOC	83442,964	1	83442,964	631,340	,000
Farm	SOC (0-15cm)	,724	2	,362	10,106	,000
	SOC (15-30cm)	,104	2	,052	2,408	,097
	SOC (30-60cm)	,209	2	,105	6,877	,002
	SOC (60-100cm)	,199	2	,099	9,447	,000
	TOC	2771,513	2	1385,756	10,485	,000
Site	SOC (0-15cm)	,203	1	,203	5,681	,020
	SOC (15-30cm)	,202	1	,202	9,317	,003
	SOC (30-60cm)	,001	1	,001	,041	,839
	SOC (60-100cm)	,009	1	,009	,827	,366
	TOC	93,928	1	93,928	,711	,402
Slope	SOC (0-15cm)	,102	1	,102	2,853	,095
	SOC (15-30cm)	,035	1	,035	1,635	,205
	SOC (30-60cm)	,027	1	,027	1,763	,188
	SOC (60-100cm)	,014	1	,014	1,347	,249
	TOC	229,036	1	229,036	1,733	,192
ErosDepos	SOC (0-15cm)	,064	1	,064	1,781	,186
	SOC (15-30cm)	,000	1	,000	,009	,925
	SOC (30-60cm)	,106	1	,106	6,939	,010
	SOC (60-100cm)	,008	1	,008	,715	,400
	TOC	255,527	1	255,527	1,933	,168
Eros20tha	SOC (0-15cm)	,193	1	,193	5,387	,023
	SOC (15-30cm)	,287	1	,287	13,242	,000
	SOC (30-60cm)	,049	1	,049	3,243	,076
	SOC (60-100cm)	,044	1	,044	4,202	,044
	TOC	905,999	1	905,999	6,855	,011
Farm * Site	SOC (0-15cm)	,211	2	,106	2,947	,058
	SOC (15-30cm)	,056	2	,028	1,286	,282
	SOC (30-60cm)	,023	2	,011	,740	,481
	SOC (60-100cm)	,021	2	,010	,975	,382
	TOC	290,995	2	145,498	1,101	,338

Farm * Slope	SOC (0-15cm)	,052	2	,026	,723	,489
	SOC (15-30cm)	,085	2	,043	1,964	,147
	SOC (30-60cm)	,061	2	,030	1,997	,143
	SOC (60-100cm)	,078	2	,039	3,686	,030
	TOC	840,041	2	420,020	3,178	,047
Farm * ErosDepos	SOC (0-15cm)	,023	2	,011	,318	,729
	SOC (15-30cm)	,006	2	,003	,128	,880
	SOC (30-60cm)	,061	2	,030	2,000	,142
	SOC (60-100cm)	,025	2	,012	1,168	,316
	TOC	285,721	2	142,860	1,081	,344
Farm * Eros20tha	SOC (0-15cm)	,033	2	,016	,459	,634
	SOC (15-30cm)	,026	2	,013	,596	,554
	SOC (30-60cm)	,016	2	,008	,517	,598
	SOC (60-100cm)	,025	2	,012	1,173	,315
	TOC	159,983	2	79,992	,605	,548
Site * Slope	SOC (0-15cm)	,013	1	,013	,366	,547
	SOC (15-30cm)	,008	1	,008	,346	,558
	SOC (30-60cm)	4,788E-05	1	4,788E-05	,003	,955
	SOC (60-100cm)	,007	1	,007	,675	,414
	TOC	63,779	1	63,779	,483	,489
Site * ErosDepos	SOC (0-15cm)	,025	1	,025	,708	,403
	SOC (15-30cm)	,016	1	,016	,727	,397
	SOC (30-60cm)	,059	1	,059	3,890	,052
	SOC (60-100cm)	,016	1	,016	1,549	,217
	TOC	178,581	1	178,581	1,351	,249
Site * Eros20tha	SOC (0-15cm)	,002	1	,002	,047	,830
	SOC (15-30cm)	,013	1	,013	,583	,447
	SOC (30-60cm)	,048	1	,048	3,138	,080
	SOC (60-100cm)	,006	1	,006	,534	,467
	TOC	71,874	1	71,874	,544	,463
Slope * ErosDepos	SOC (0-15cm)	,002	1	,002	,062	,805
	SOC (15-30cm)	,010	1	,010	,483	,489
	SOC (30-60cm)	,035	1	,035	2,286	,135
	SOC (60-100cm)	,019	1	,019	1,847	,178
	TOC	191,991	1	191,991	1,453	,232
Slope * Eros20tha	SOC (0-15cm)	,132	1	,132	3,699	,058
	SOC (15-30cm)	,081	1	,081	3,748	,057
	SOC (30-60cm)	,007	1	,007	,431	,513
	SOC (60-100cm)	,026	1	,026	2,452	,121
	TOC	216,268	1	216,268	1,636	,205

ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Farm * Site * Slope	SOC (0-15cm)	,258	2	,129	3,606	,032
	SOC (15-30cm)	,017	2	,008	,384	,682
	SOC (30-60cm)	,065	2	,033	2,138	,125
	SOC (60-100cm)	,046	2	,023	2,177	,120
	TOC	849,129	2	424,565	3,212	,046
Farm * Site * ErosDepos	SOC (0-15cm)	,006	2	,003	,079	,924
	SOC (15-30cm)	,026	2	,013	,597	,553
	SOC (30-60cm)	,031	2	,016	1,020	,365
	SOC (60-100cm)	,015	2	,008	,717	,492
	TOC	117,096	2	58,548	,443	,644
Farm * Site * Eros20tha	SOC (0-15cm)	,049	2	,024	,678	,511
	SOC (15-30cm)	,032	2	,016	,727	,487
	SOC (30-60cm)	,006	2	,003	,185	,832
	SOC (60-100cm)	,004	2	,002	,175	,839
	TOC	36,704	2	18,352	,139	,871
Farm * Slope * ErosDepos	SOC (0-15cm)	,162	1	,162	4,532	,036
	SOC (15-30cm)	6,316E-05	1	6,316E-05	,003	,957
	SOC (30-60cm)	,046	1	,046	3,022	,086
	SOC (60-100cm)	,008	1	,008	,770	,383
	TOC	79,382	1	79,382	,601	,441
Farm * Slope * Eros20tha	SOC (0-15cm)	,000	1	,000	,009	,925
	SOC (15-30cm)	,006	1	,006	,287	,594
	SOC (30-60cm)	,030	1	,030	1,991	,162
	SOC (60-100cm)	,014	1	,014	1,342	,250
	TOC	212,871	1	212,871	1,611	,208
Farm * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Site * Slope * ErosDepos	SOC (0-15cm)	,006	1	,006	,170	,681
	SOC (15-30cm)	,000	1	,000	,013	,909
	SOC (30-60cm)	,000	1	,000	,023	,879
	SOC (60-100cm)	,011	1	,011	1,025	,314
	TOC	24,010	1	24,010	,182	,671

Site * Slope * Eros20tha	SOC (0-15cm)	,050	1	,050	1,383	,243
	SOC (15-30cm)	,000	1	,000	,015	,903
	SOC (30-60cm)	,015	1	,015	,954	,332
	SOC (60-100cm)	,003	1	,003	,303	,584
	TOC	,102	1	,102	,001	,978
Site * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Slope * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Farm * Site * Slope * ErosDepos	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Farm * Site * Slope * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Farm * Site * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Farm * Slope * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Site * Slope * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			

Farm * Site * Slope * ErosDepos * Eros20tha	SOC (0-15cm)	0,000	0			
	SOC (15-30cm)	0,000	0			
	SOC (30-60cm)	0,000	0			
	SOC (60-100cm)	0,000	0			
	TOC	0,000	0			
Error	SOC (0-15cm)	2,793	78	,036		
	SOC (15-30cm)	1,692	78	,022		
	SOC (30-60cm)	1,187	78	,015		
	SOC (60-100cm)	,821	78	,011		
	TOC	10309,099	78	132,168		
Total	SOC (0-15cm)	62,816	108			
	SOC (15-30cm)	27,201	108			
	SOC (30-60cm)	14,421	108			
	SOC (60-100cm)	8,367	108			
	TOC	203185,322	108			
Corrected Total	SOC (0-15cm)	8,503	107			
	SOC (15-30cm)	4,023	107			
	SOC (30-60cm)	3,066	107			
	SOC (60-100cm)	2,128	107			
	TOC	30797,366	107			

a. R Squared = ,671 (Adjusted R Squared = ,549)

b. R Squared = ,579 (Adjusted R Squared = ,423)

c. R Squared = ,613 (Adjusted R Squared = ,469)

d. R Squared = ,614 (Adjusted R Squared = ,471)

e. R Squared = ,665 (Adjusted R Squared = ,541)