Present use and physical properties relationships in soils under mediterranean semiarid conditions

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Abstract
Physical soil properties have been widely proposed as an indicator of soil quality. The aim of this study was identify the relationships between physical soil properties and present uses. Attending to the high level of soil degradation and the stressful environmental characteristics, the Mazarrón area (S.E. Spain) was selected for this study. Structural stability, bulk density, texture and available water were analysed for forty-one soil samples from the study area. Physical soil parameters were correlated with soil uses and a strong relationship between structural stability and soil uses was observed.

Key Words
Soil physical properties, soil use, soil quality, semiarid soil.

Introduction
An appropriate characterisation of physical properties is considered necessary for soil quality evaluation (Singer and Ewing 2000). The physical properties that can be used for the development of soil quality index are those able to modelling the mechanisms of collecting and storage of soil water and its transmission to the plants, in addition to other soil functions as the improvement of root growing and plant shoots and the infiltration or water dynamic within the soil profile, closely correlated with pore size and distribution. Water retention and storage capacity, the structural stability (De Ploey and Poesen 1985) and texture were the physical characteristics selected as soil quality indicators in the study area. An area of Murcia Region prone to soil physical degradation due to environmental conditions and human pressure were selected for this study. In addition, the study area shows a high variability in soil types and mineralogy (Delgado 1998), with soil developed from igneous metamorphic and sedimentary materials. Likewise, soil uses experienced many changes in recent years (Muñoz 1998). The objective of this study was to study the relationships between soil physical properties and present land use.

Methods
Field methods
From the area in the sheet 976 of the Mazarrón SoilMap 1:50.000, forty-one surface oil samples (0-30 cm.) were taken according to a regular net of 3 x 3 m. Each soil sample was constituted by three mixed sub-samples. For the data processing soils were classified in four groups as present use: natural vegetation, cropland, grassland and urban-industrial.

Laboratory methods
Soils were classified following the "World Reference Base for Soil Resources 2006" (FAO-ISRIC-IUSS, 2006). Surface soil samples (0-30 cm) for laboratory analysis were sieved through 2 mm mesh. Additionally, undisturbed soil cores were collected using sample rings (5-cm diameter and 5-cm height). The following physical parameters were determined: *Soil texture* was analysed following the method described in Soil Survey Report Nr.1 (Soil Conservation Service, 1972). *Structural stability* was determined through the percentage of (0.2-4 mm) stable aggregates of the soil subjected to a simulated rainfall of 150 mm and 270 J/m^2 energy (Lax *et al.* 1994). *Bulk density* was determined from the undisturbed soil core samples dried in a oven at 105 ºC and weighed (Henin *et al.* 1969). *Real density* was determined through the volume of removed water after submerging a known weight of soil within a gauged glass vessel. Porosity was calculated from bulk and real density values. *Water retention capacity* was determined by membrane method (Richards, 1941) at 1/3 atm (field capacity) and 15 atm (wilting point). *Available Water (AW)* was considered the difference between water retained at pF 1/3 and 15 atm.

Statistical methods
Analytical results were processed through a basic descriptive statistic using the SPSS 15.0 program for Windows.

Results
A strong relationship between structural stability and soil use was observed. In this ay, the non cultivated soils showed 75% of stable aggregates, while in the cropland soils this average decreased to 44% (Table 1). This reduction must be due to continuous destruction of soil structure as a consequence of agricultural practice such as tillage, the use of heavy machinery, the decrease of organic matter, among other factors. Likewise, a decrease of stable aggregates occurred in grassland due to cattle treading which led to soil compaction and structural degradation.

Table 1. Soil use and percentage of stable aggregates.

Soil use	Nº samples	S.A %
Cropland	14	43,9
Natural vegetation	22	74,2
Grasland	3	63,4
Urban /industrial	2	49,5
Total	41	

On the contrary, no relationship was observed between bulk density and soil use as it occurred with the porosity (Table 2). So in the soils with natural vegetation the porosity was the highest (30%), while in the cropland and urban soils the porosity was similar (26%).

Table 2. Real density, bulk density and porosity according to soil use.

Soil use	Nº samples	Bulk density (gr cm^3)	Real density (gr cm^3)	Porosity (%)
Cropland	14	1,26	1,71	26
Natural vegetation	22	1,21	1,75	30
Grasland	3	1,23	1,72	28
Urban/industrial	2	1,26	1,71	26
Total	41			

The particle-size distribution did not show differences among the uses, being the particle-size fraction averages very similar in all the uses. Only in urban soils a small increase can be observed in the sand fraction (Table 3).

Table 3. Contents granulometric as soil use.

Soil use	Nº samples	% Sand	% Silt	% Clay
Cropland	14	42,8	39,8	17,3
Natural vegetation	22	49,7	36,2	14,2
Grasland	3	46,2	40,0	13,8
Urban/industrial	2	57,2	30,0	12,8
Total	41			

Likewise, no differences were found between water retention capacity and soil use. The pF values both at "field capacity" (pF=1/3atm) and at "wilting point" (pF=15atm) were very similar in all the uses. As a consequence of this, the soil available water was not affected by the soil use (Table 4).

Table 4. pF 15, pF 1/3 and available water according to soil use.

Use	Nº samples	pF 1/3	pF15	A.W (%)
Growing	14	24,1	9,4	14,7
Natural	22	23,8	10,9	12,9
Pasturage	3	26,8	11,5	15,4
Urbanized/industrial	2	25,3	10,0	15,3
Total	41			

Conclusion

Structural stability was the physical property that showed the highest sensitivity as a soil quality index in these soils. The average stable aggregate percentage was higher than 50% and was strongly linked to soil use in the study area. The soils under natural vegetation preserved from anthropic perturbation showed the highest structural stability. Cropland and urban soils were poorly structured and in grassland the structure was acceptable. The water retention capacity and available water did not show differences among the soil uses and can not be used, for this soil as a soil quality indicator.

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