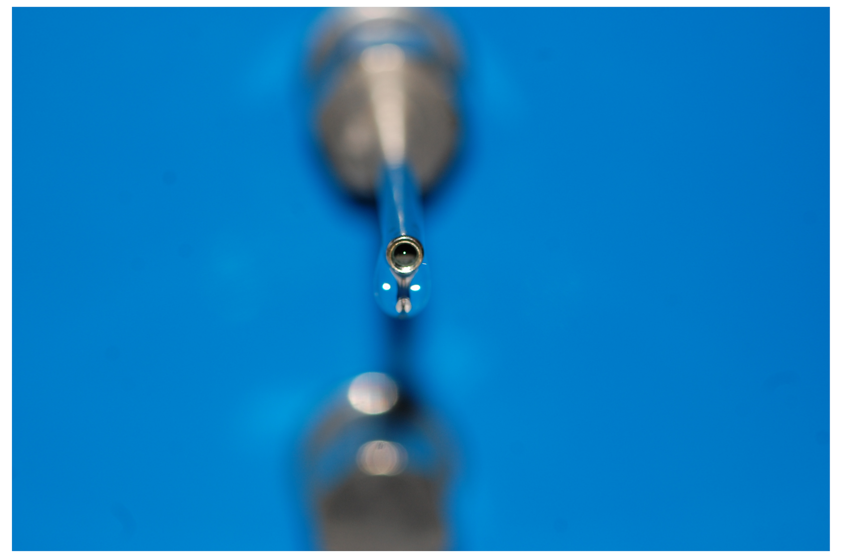
HYDROLOGICAL PROPERTIES OF NATURAL AND RECONSTITUTED SOILS: COMPARED METHODS



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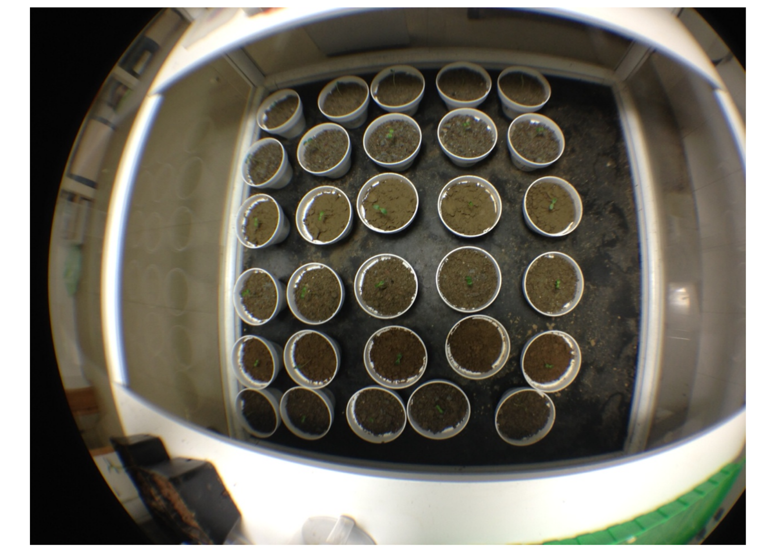


NEW LIFE

www.lifeplusecosistemi.eu
LIFE10 ENV/IT/000400 NEW LIFE
total budget 4.025.473.00 euro
EU contribution 1.929.837.00 euro

This study is part of a LIFE+ project - "Environmental restoration of degraded soils and desertified by a new treatment technology for the recovery of the land" (Life 10 ENV/IT/000400 "New Life") - which aims to test a new treatment - patented by the company M.C.M. Ecosistemi - for recovering soils to contrast degradation. The reconstitution treatment consists in chemical-mechanical actions where a disgregation is followed by a recovery - incorporating soil improvers - by a subsequent polycondensation with humic acids and by a final reconstitution.

The effectiveness of the reconstitution will be tested on different soils used for the closure of a municipal solid waste landfill near Piacenza. For this reason experimental plots are prepared; in the plots the chemical-physical parameters of different types of soils - landfill and others soils - are compared with the same reconstituted soils. The plots soils will be constantly monitored.

THE PURPOSE OF THIS WORK IS TO DESCRIBE AND COMPARE THE HYDROLOGICAL CHARACTERS OF NATURAL AND RECONSTITUTED SOILS USING DIFFERENT TECHNIQUES.

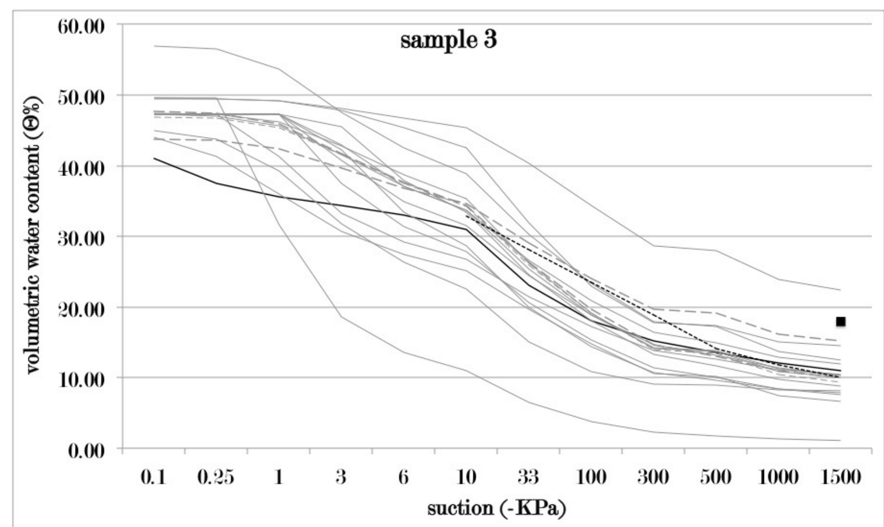
The natural soils used are: sandy soil (86.2% sand), silty soil (42.5% sand, 49.9% silt) and clay soil (54.6% clay, 38.5% silt).

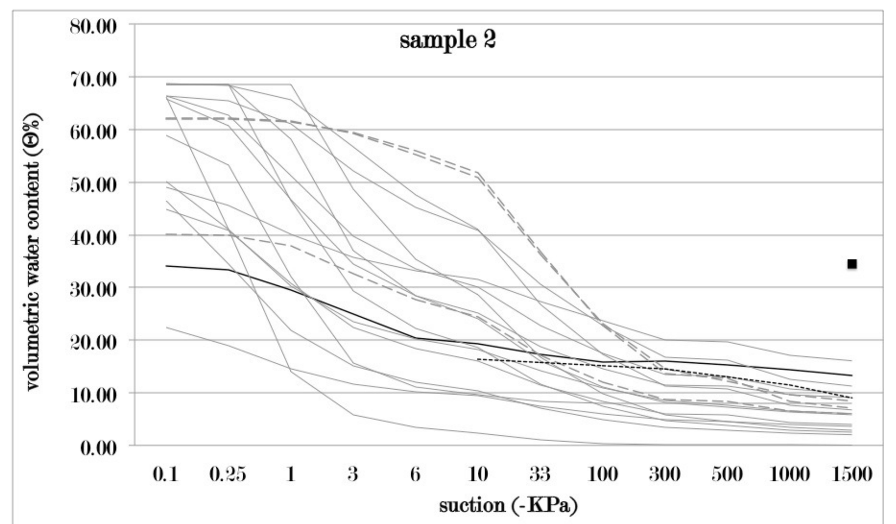
The soils water retention analysis were performed in 3 ways:

- using Richards plates on undisturbed samples;
- using Richards plates on disturbed samples;
- using potted trial to determine the moisture at wilting point. The trial, began in november 2013, is still in progress, and so in this work only partial results are presented. This test consists in sunflower farming to a height of 15-20 cm, then in stopping watering and closing the pots to avoid evaporation, in waiting until the plant dies and then determine the soil moisture - the soil wilting point.

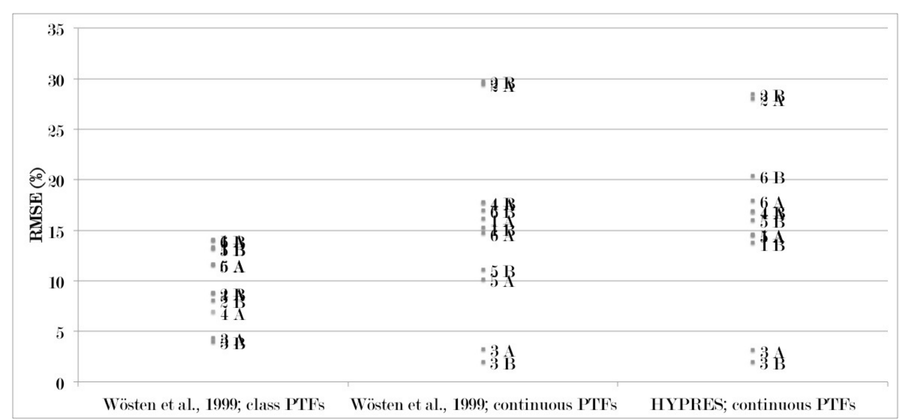
The laboratory data were compared with the results of pedotransfer functions (PTFs) based on two models: van Genuchten and Brooks and Corey. The study focused on those developed on a European soils database: HYPRES (Wösten et. al,1999). From HYPRES two different classes of PTFs are derived: class PTFs - PTFs that predict the hydraulic behavior of the soils on the basis of their texture - and continuous PTFs - PTFs that predict the hydraulic behavior from data of texture, organic carbon content and bulk density. It's used, also, the program CalcPTF 3.0.

The Wösten et. al, 1999 PTFs generated in HYPRES and by CalcPTF have been compared by RMSE test.





- undisturbed soil
- disturbed soil
- trial in pot
- Wo"sten et al., 1999, class PTFs
- Wo"sten et al., 1999, continuous PTFs
- HYPRES, continuous PTFs



A: indisturbed soil   B: disturbed soil

	RMSE (%)											
	1 A	1 B	2 A	2 B	3 A	3 B	4 A	4 B	5 A	5 B	6 A	6 B
Wösten et al., 1999; class PTFs	14	13	9	8	4	4	7	9	12	13	12	14
Wösten et al., 1999; continuous PTFs	16	15	29	30	3	2	18	18	10	11	15	17
HYPRES; continuous PTFs	15	14	28	28	3	2	17	17	15	16	18	20

The best RMSE is for the sample 3 - silty soil - while the worst is for the sample 2 - reconstituted sandy soil. For all the samples the RMSE between disturbed and undisturbed sample are very similar to each other.

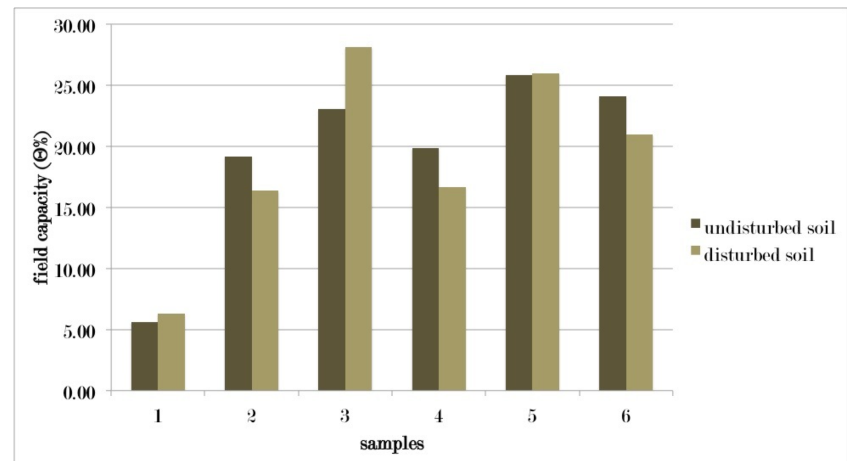
The best and similar RMSE are in class PTFs.

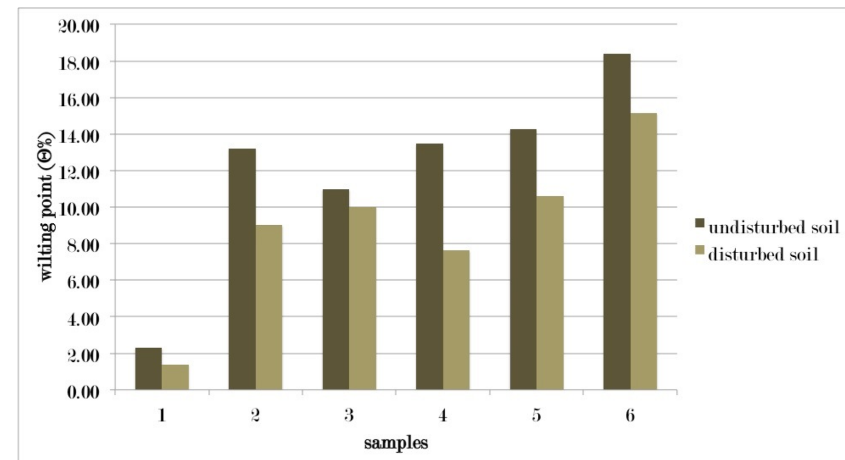
The worst and different RMSE are in continuous PTFs.

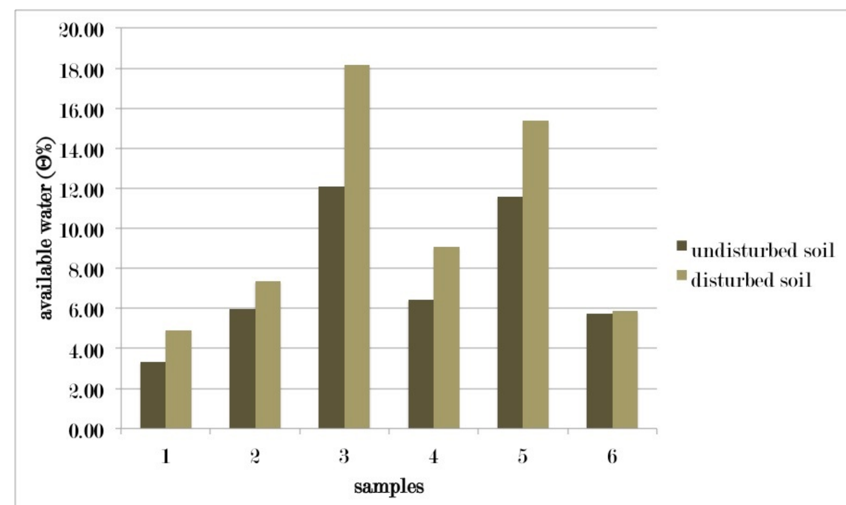
It can be argued that soil organic carbon concentration and bulk density take a great change in the PTFs that fail in describing the hydraulic behavior of these soils.

sample	particle density	bulk density	sand	silt	clay	O.C.
	g/cm^3	g/cm^3	%	%	%	%
1	2.65	1.48	86.2	13.8	0.0	0.10
2	2.26	0.71	86.2	8.5	5.2	2.76
3	2.39	1.26	42.5	49.9	7.5	1.83
4	2.09	0.69	61.6	33.5	4.6	2.94
5	2.25	1.27	6.8	38.5	54.6	0.27
6	1.89	0.82	32.3	28.3	39.4	5.45

sample	name
1	sandy soil
2	reconstituted sandy soil
3	silty soil
4	reconstituted silty soil
5	clay soil
6	reconstituted clay soil







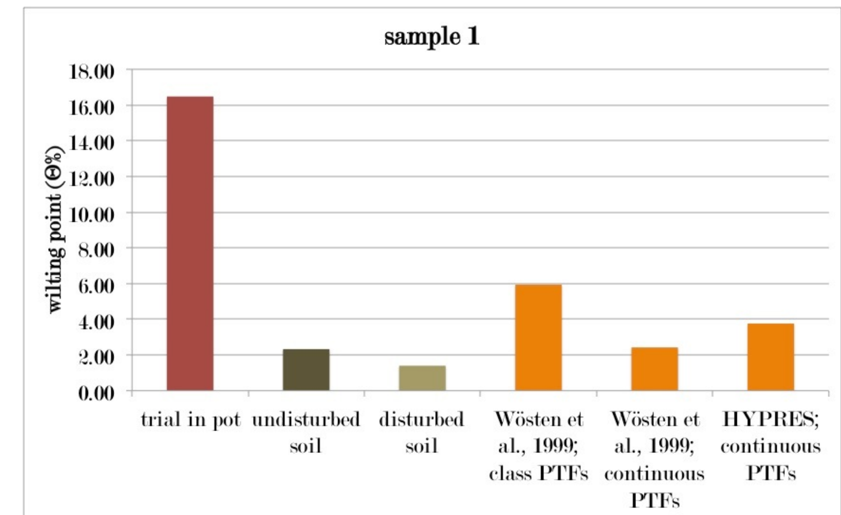
	volumetric water content (Θ%) at different suction (-KPa)					
	10	33	100	316	1000	1500
1A	5.64	4.51	3.70	3.17	2.64	2.33
1B	6.29	5.18	4.06	1.99	1.54	1.40
2A	19.21	17.29	15.83	16.05	14.35	13.22
2B	16.37	15.76	15.14	14.53	13.01	11.48
3A	30.92	23.07	17.99	15.16	12.03	10.98
3B	32.82	28.16	23.49	18.81	14.13	11.82
4A	24.00	19.89	17.42	16.69	15.05	13.47
4B	19.86	16.69	14.95	12.83	9.08	7.63
5A	27.07	25.86	23.26	19.76	15.40	14.28
5B	33.12	25.99	23.43	14.89	11.75	10.61
6A	27.17	24.14	21.49	20.73	19.63	18.39
6B	24.41	21.01	19.92	18.82	17.45	16.07

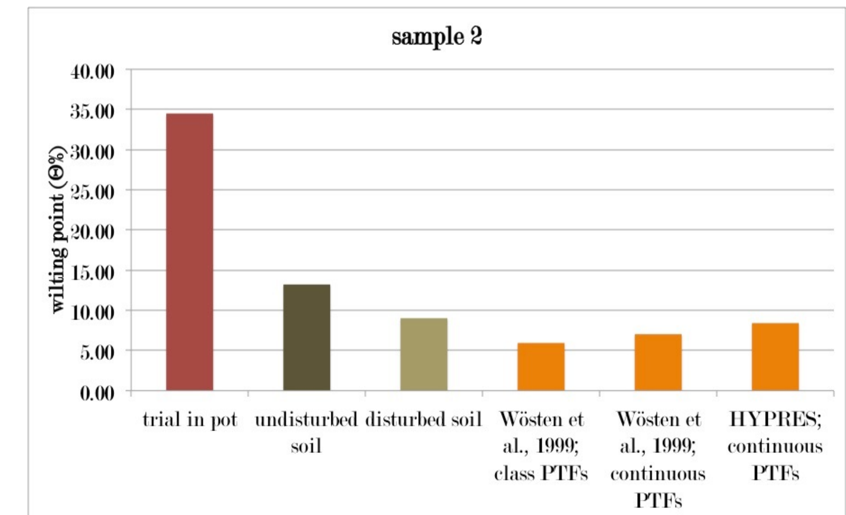
The comparison between disturbed and undisturbed natural soils for suction values less than 100 KPa shows that undisturbed soils always have moisture contents lower than disturbed soils. For suction values greater than 100 KPa - with the exception of sample 3 - silty soil - all undisturbed samples have highest values of disturbed samples.

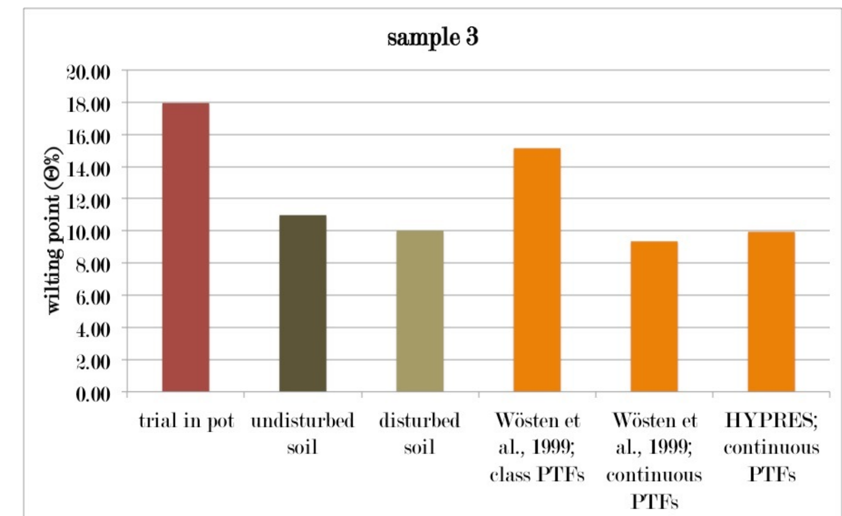
On the contrary the comparison between disturbed and undisturbed reconstituted soils shows that the undisturbed soils have always highest values of disturbed soils.

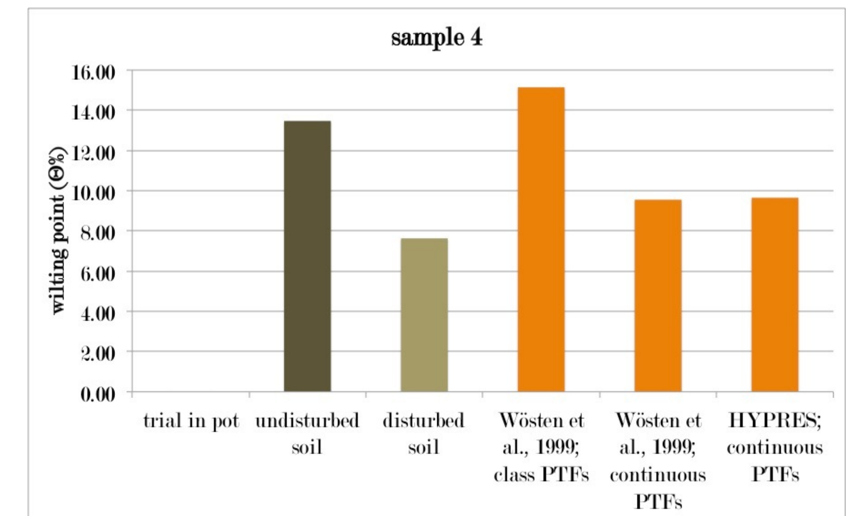
The content of water available for the plants - calculated by the difference between soil moisture content at field capacity and at wilting point - is always highest for undisturbed samples.

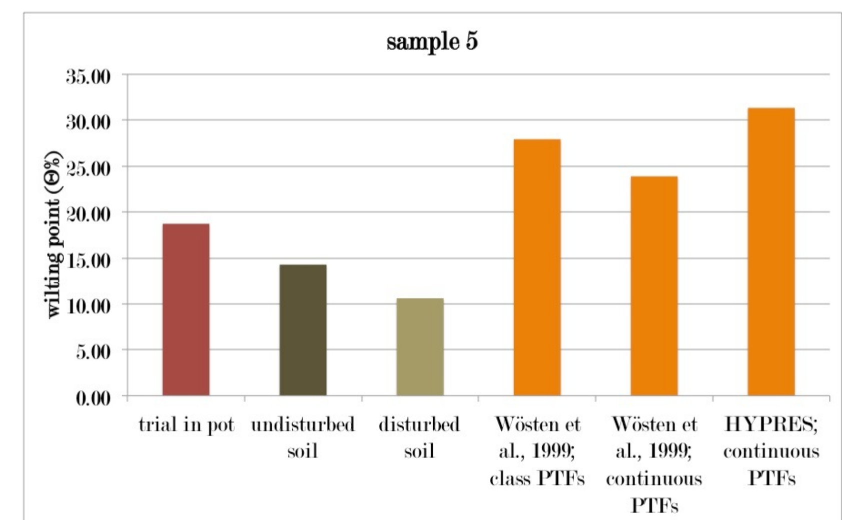
It is not possible today to express opinions in using disturbed or undisturbed samples; it can be said that the analysis turns out to be easier and faster on disturbed samples, but that the disturbance applied by sieving and screening influences the structure of the soil going to affect the data. This should be considered if the intent is to compare the field with laboratory data.

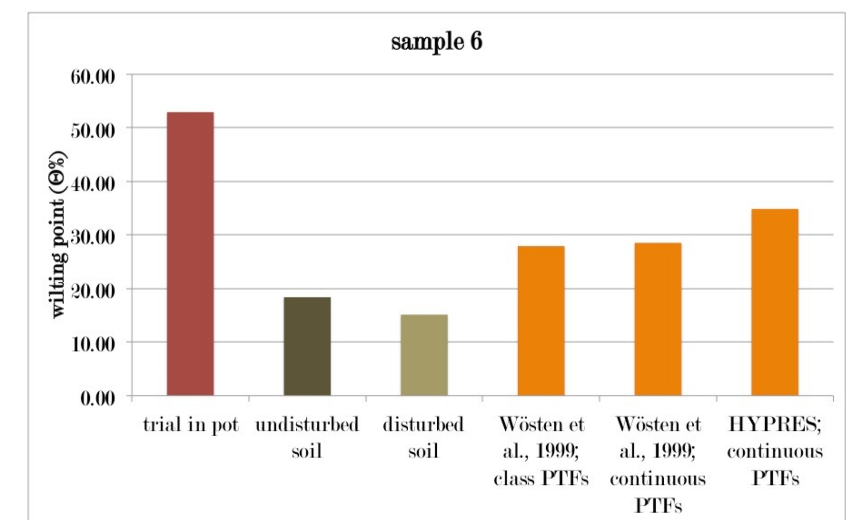












The histograms show the comparisons between the moisture content at wilting point determined by analysis and by PTFs; (for sample 4 - reconstituted silty soil - lacks the trial in pot histogram because the test is not finished yet). The soil moisture determined by the trial in pot results always greater than by laboratory tests, supporting the hypothesis that this is not a reliable and precise method, in addition to being very long and difficult to manage.

The sample 2 - reconstituted sandy soil - is the only one that has the measured moisture content at wilting point less than that by the PTFs.

The samples 3 and 4 - natural and reconstituted silty soil - have the measured moisture content at wilting point very close to those of the PTFs.

The samples 5 and 6 - natural and reconstituted clay soil - have the measured moisture content at wilting point very different from those of PTFs.

From what it can be said that the majority of "fine" texture component negatively affects the performance of the PTFs, while the majority of "coarse" texture component allows PTFs to describe in a better way the soil real behavior.

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European Geosciences Union,
General Assembly 2014
Vienna, Austria 27 April - 02 May 2014