Report on SQAPP Assessment as a tool to monitor soil quality improvement.

Part 1. Correlation results and discussion

Project: iSQAPER | Work Package 6 | Task 6.3

Authors: Fernando Teixeira & Gottlieb Basch

Working Paper

Abstract

This is a preliminary study on the agreement of measured soil properties from 37 georeferenced locations in Europe and China and the values estimated by SQAPP for the same locations. Of the 13 properties analysed, only sand content showed a strong positive correlation between measured and estimated values, 9 presented a moderate correlation and 3 a weak correlation. 6 of the moderate and weak correlations were negative. With the exception of the weak correlated (measured/ estimated) properties (Macrofauna, N and K), and Electrical Conductivity, all other correlations had statistical significance. For all properties, agreement between measured and estimated values was low. The standard error of the estimate was calculated for each SQAPP estimated soil property. The impact on the soil status estimate classification (low/ medium/ high) for each soil threat considered in the iSQAPER project and agreement with observed soil status classification based on measured soil properties is discussed.

Introduction

In this report we discuss the correlation and the agreement between measured physical, chemical and biological soil properties, and the values estimated by the Soil Quality App (SQAPP) for the same location. The final goal is to assess if SQAPP can be used to monitor soil quality improvement, for each property and at specific locations.

Materials and Methods

In the scope of the iSQAPER project, WP6, task 6.1, innovative agricultural management practices (AMPs) were first chosen at 14 case study sites (Barão and Basch, 2017) for evaluation and demonstration purposes. A final set of 24 georeferenced pairs of AMPs and control fields was defined (see Annex 1), at 13 CSSs, and the CSSs were asked to collect the data needed to assess threats and soil quality status by answering a questionnaire and measure soil physical, chemical and biological properties (see Annex 2). Of the 13 CSSs, only 9 complied with the deadline set to provide a filled questionnaire. The questionnaire from The Netherlands is semi-filled and the questionnaire from France arrived after the deadline. Until the end of the project, we plan to include in this study all data, including the still missing data from Estonia and Hungary.

The correlation studies between measured soil properties values and estimated soil properties values by SQAPP present different number of pairs (measured/estimated), 19 to 37 pairs, due to lack of information either in SQAPP or not provided by the CSS (see Table 1). The data from SQAPP was compiled with the beta version released in June 2018 (compilation occurred from June to November 2018).

Table 1. Origin of the data used in the correlation studies.

	NL	SQ APP	PT	SQ APP	SP	SQ APP	GR	SQ APP	SI	SQ APP	RO	SQ APP	PL	SQ APP	CN-Qiyang	SQ APP	CN-Suining	SQ APP	CN-Gongz.	SQ APP
Clay	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Silt	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sand	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bulk Density		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Coarse Fragments		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SOC	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
pH	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Electrical Conductivity		x	x	x	x	a	x	x	x	x	x	x	x	x	x	a	x	x	x	x
Exc. K	x	x	x	x	x	a	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P (Olsen)	x	a	x		x	a	x	a	x	x	x	x	x	a	x	a	x	x	x	x
Total N	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Microbial Biomass		x		x	x	a	x	a	x	x	x	x	x	x	x	x	x	x	x	x
Fauna groups		x	x	x	x	x	x	a	x	x	x	x		x		x		x		x

Grey- no data provided by the CSS; Blue- no data registered in SQAPP; a data available in SQAPP only at 1 location.

For some soil properties, the measured values did not cover the entire range of possible values, and the correlations and regressions reflect, in some instances, this constraint.

Statistical analysis

Association between measured soil properties (physical, chemical and biological) and estimated values by the Soil Quality App (SQAPP) were tested by Pearson correlation coefficient and, to determine if the association between measured and estimated were statistically significant, the respective t values were calculated, both with Excel (Microsoft Office Professional Plus 2013). The standard error of the estimate was calculated.

Results

Correlation study results

The correlation results between measured soil properties values and values estimated by SQAPP can be found in table 2.

Of the texture related soil properties, only sand content showed a strong correlation between measured and estimated (r=0.77). Other texture components (clay, silt and coarse rock fragments), showed a correlation coefficient in the borderline between moderate and strong correlation (0.68 to 0.70). In terms of agreement between measured and estimated values of texture components, due to the nature and scope of application of SQAPP, points should disperse closely around the equality line, *i.e.* the intersection of the regression line should be close to 0 and the slope close to 1. That's not the case, and it can be observed that SQAPP overestimates values to the left side of the interval, to the left of the point where the regression line crosses the equality line, and underestimates to the right (see Figure 1). The estimated values of texture components varies in a relatively short interval in most of the range of possible values, except for extreme values, *e.g.* silt estimates vary between 34 and 47% (one exception) for measured silt between 11 and 79%. For clay, although the same trend can be expected, georeferenced location with higher clay content are needed.

Table 2. Correlation between measured soil properties values and values estimated by SQAPP (dependent variable).

	n	Measured	Estimated	r	Regression equation	R^2	Stat. Sig. α	SER
Sand (%)	37	[2,89]	[23,82]	0.77	y = 0.4983x + 15.333	0.60	0.001	10.97
Clay (%)	37	[1,34]	[5,30]	0.70	y = 0.5604x + 13.947	0.48	0.001	5.65
Silt (%)	37	[6,79]	[12,57]	0.68	y = 0.3061x + 26.09	0.46	0.001	7.91
C. F. (%)	27	[0,45]	[1,17]	0.70	y = 0.2375x + 4.0079	0.49	0.001	3.49
B.D. (Mg m^{-3})	33	[1.03,1.75]	[1.27,1.62]	-0.42	y = -0.2272x + 1.7067	0.17	0.05	
SOC (%)	37	[0.53,4.3]	[0.7,4.6]	0.58	y = 0,4918x + 1,4866	0.34	0.01	0.87
pH	37	[4.86,8.35]	[5.3,7.9]	0.57	y = 0.4482x + 3.7755	0.32	0.01	0.66
E.C. (dS m^{-1})	26	[0.02,1.64]	[0.1,7.2]	-0.30			ns	
P (mg kg^{-1})	21	[4.9,583]	[2.7,5.5]	-0.54	y = -0.0032x + 3.9529	0.29	0.05	
Exc. K (mg kg^{-1})	33	[55,544]	[63,489]	-0.12			ns	
Total N (mg kg^{-1})	35	[665,3700]	[570,1730]	-0.08			ns	
Microbial C (g m^{-2})	23	[64,924]	[47,150]	0.60	y = 0.0705x + 76.843	0.36	0.01	24.31
Macrofauna (n)	19	[0,5]	[1,8]	-0.04			ns	

C. F. (%): Coarse rock fragments (%); ns: not statistically significant; (n): number of groups

Bulk density (BD) presented a negative moderate correlation, but statistically significant at α=0.05, between measured and SQAPP estimates (see Figure 2).

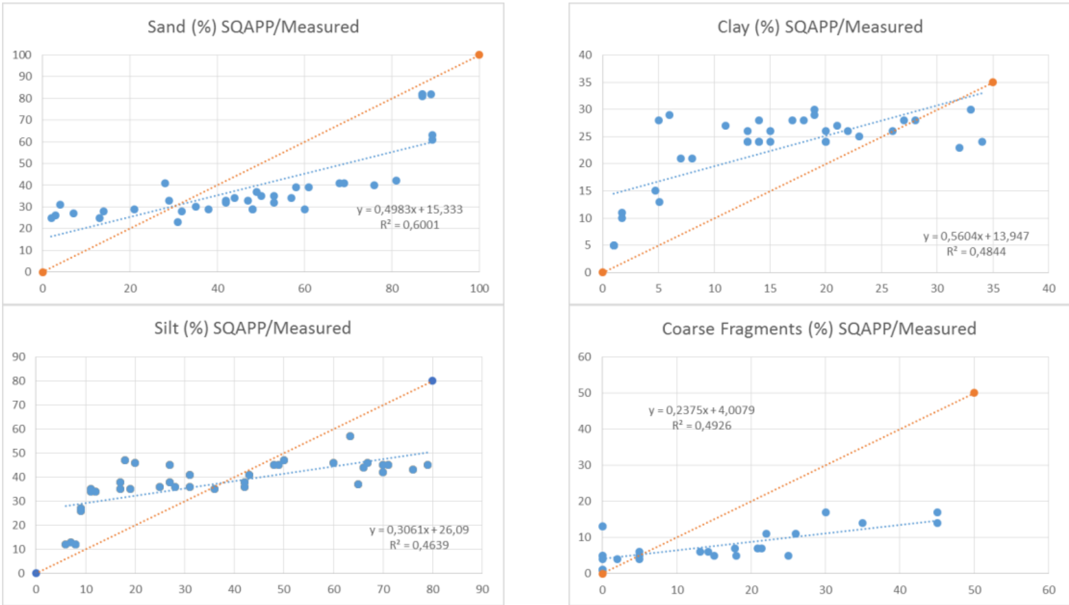

Figure 1. Estimation (y) vs measured (x) dispersions of texture components, regression lines (blue) and equality line (orange).

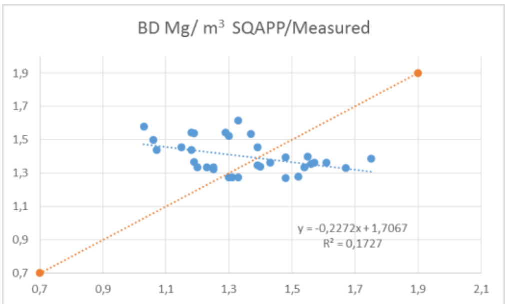

Figure 2. Estimation (y) vs measured (x) dispersion of bulk density, regression lines (blue) and equality line (orange).

For soil organic carbon (%) (SOC), SQAPP showed the same trend to overestimate values to the left side of the interval, to the left of the point where the regression line crosses the equality line, and underestimates to the right (see Figure 3). Further analysis showed that for this property, the use of values from the AMPs fields and Control fields separately correlated differently with SQAPP estimates: the calculated correlation between measured and estimated SOC values for AMP fields produced a lower correlation (r=0.47, not statistically significant), and when the values measured for the control fields were used the correlation raised (r=0.69, statistically significant for α=0.01).

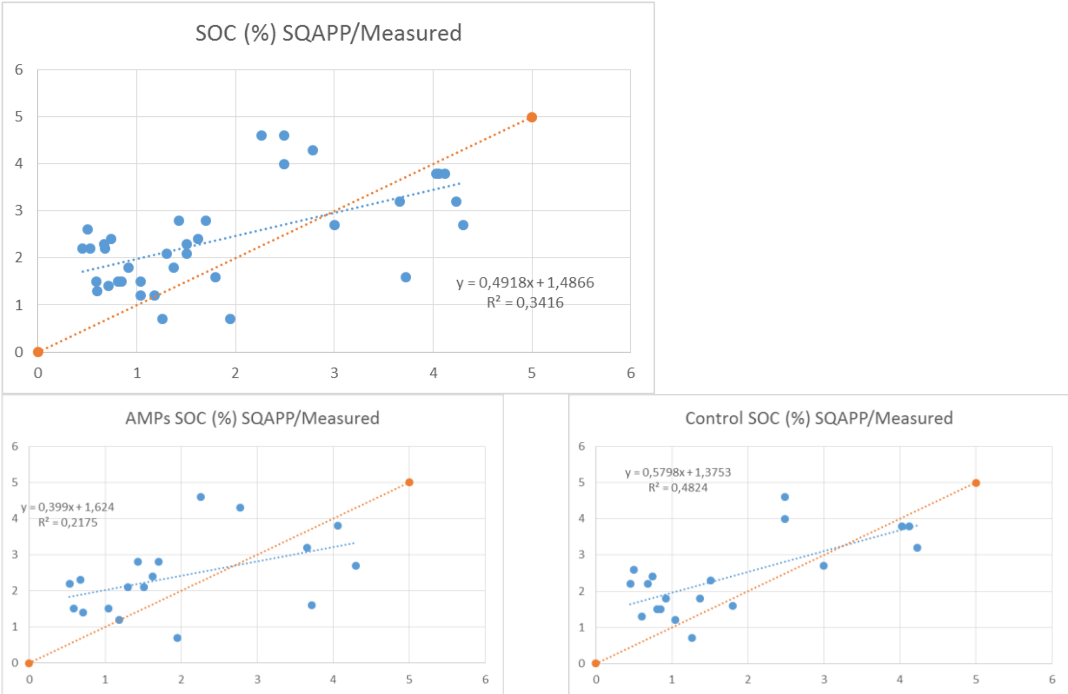

Figure 3. Upper part: Estimation (y) vs measured (x) dispersion of SOC, regression lines (blue) and equality line (orange) (r=0.58, statistically significant for α=0.01). Lower part: Estimation (y) vs measured (x) dispersion of SOC for AMP and Control fields. Correlation between measured and estimated SOC dropped when only values for the AMPs were used (r=0.47), and the correlation was not statistically significant, and the correlation increased when values of the Control fields were used (r=0.69, statistically significant for α=0.01).

For soil pH, the dispersion cluster closely to the equality line but SQAPP showed the same trend to overestimate values to the left side of the interval, to the left of the point where the regression line crosses the equality line, and underestimates to the right (see Figure 4). Further analysis showed that for this property, the use of values from the AMPs fields and Control fields correlated differently with SQAPP estimates: the calculated correlation between measured and estimated pH values for AMP fields produced a lower correlation (r=0.48, statistically significant for α=0.05), and when the values measured for the control fields were used the correlation raised (r=0.65, statistically significant for α=0.01).

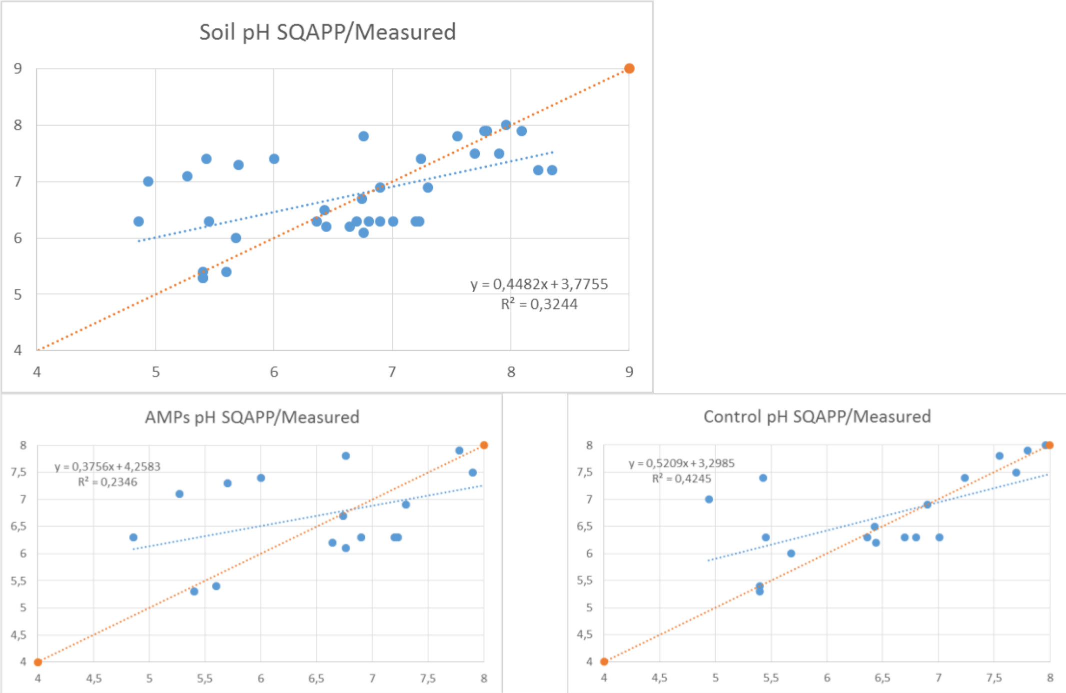

Figure 4. Upper part: estimation (y) vs measured (x) dispersion of pH, regression lines (blue) and equality line (orange) (r=0.57, statistically significant for α=0.01). Lower part: estimation (y) vs measured (x) dispersion of pH for AMP and Control fields. Correlation between measured and estimated pH dropped when only values for the AMPs were used (r=0.48, statistically significant for α=0.05), and the correlation increased when values of the Control fields were used (r=0.65, statistically significant for α=0.01).

Values of estimated and measured electrical conductivity (EC) showed no statistically significant correlation. All sites of the study have a low electrical conductivity (< 1.64 dS m^{-1}) and georeferenced locations with higher EC are needed for a more meaningful study.

For Nutrient Status, the correlations between measured and estimated Total N, and between measured and estimated Exc. K, were very weak, respectively r=-0.08 and r=-0.12. For the correlation between measured and estimated available P (Olsen), the correlation was moderate but negative (r=-0.54, statistically significant for α=0.05). In terms of agreement, estimated values of available P were consistently low, 2.7 to 5.5 mg kg^{-1}, whereas the measured values varied between 4.9 and 593 mg kg^{-1}, and the regression presents a slope of -0.0032, and interception 3.9529 (see Figure 5).

Measured vs estimated Microbial biomass C (g m^{-2}) correlation was moderate (r=0.60). The agreement between estimated and measured was low, as can be inferred by the regression, slope 0.0705, and interception 76.843. In terms of macrofauna, the correlation is very weak (r=-0.04) (see Figure 6).

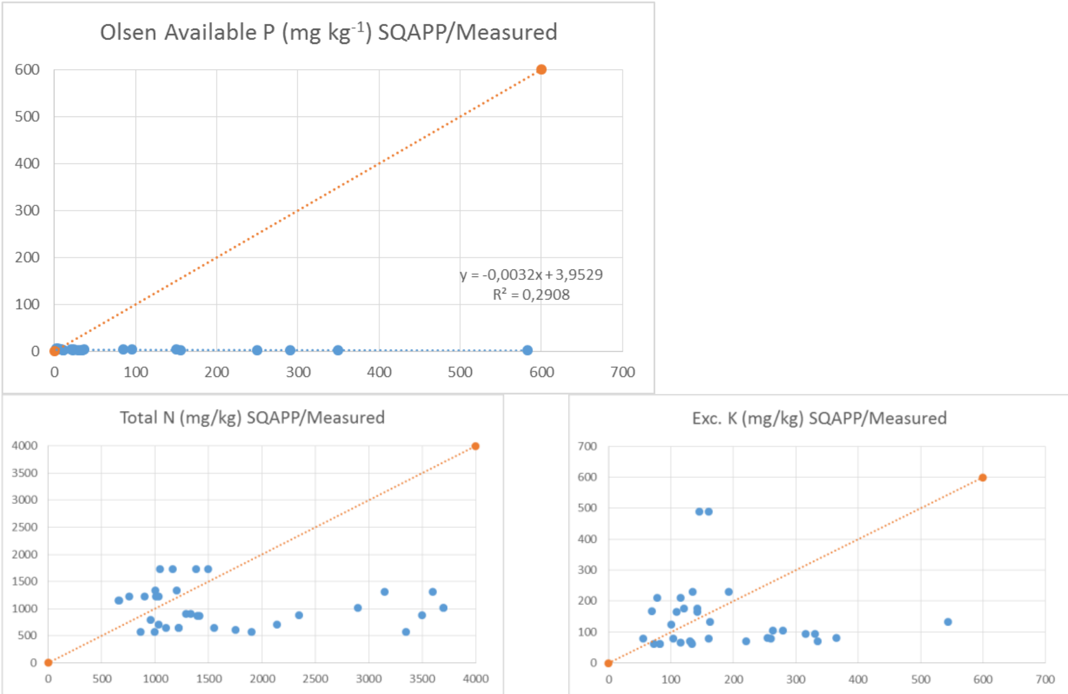

Figure 5. Estimation (y) vs measured (x) dispersions of available P (Olsen), total N and exchangeable K, regression lines (blue) and equality line (orange).

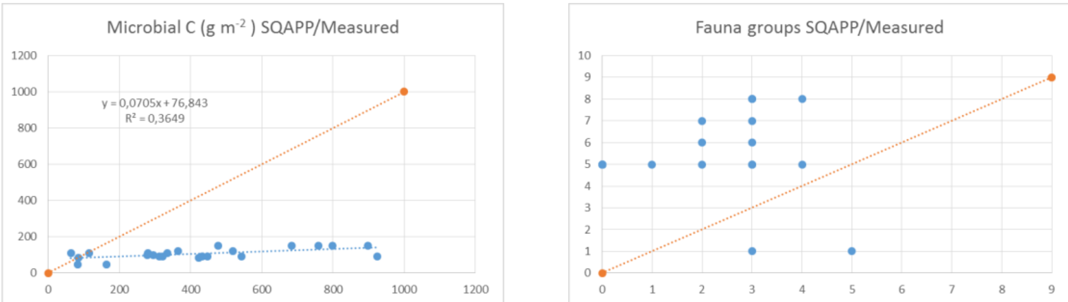

Figure 6. Estimation (y) vs measured (x) dispersions of microbial biomass C and macrofauna, regression lines (blue) and equality line (orange).

SQAPP soil quality status estimate

The soil quality status for each threat, estimated by SQAPP, and classified with base on the estimated values for soil properties and thresholds (for thresholds, see Annex 3), was studied in terms of agreement with the classification based on the measurement of the soil properties (Table 3).

Of the 37 fields assessed, SQAPP assessed the simple texture class of FAO of 19 fields correctly (51%). For the calculus of the packing density (PD), the use of the estimates for clay and bulk density, reduced further the correctness of the results, only 12 fields out of 37 (32%).

For soil organic matter (SOM) decline and Acidification (pH), the classification accuracy of SQAPP values was similar, respectively 16 and 17 out of 37 fields (respectively 43 and 46%).

Regarding Salinization, the electrical conductivity (EC) classification and high agreement of SQAPP estimate with measured classification (agreement in 23 out of 26 fields, i.e. 88%) has limited meaning because the range of the EC of the fields selected for the study correspond only to one class (<2 dS m^{-1}).

In terms of Nutrient depletion, soil status of available P agreed only 6 out of 21 fields, 29%, exc. K and total N, behaved similarly, with 11 out of 33 fields.

For soil threat status classification and distribution by classes of estimated and measured classification of the 37 fields, see Annex 4.

Table 3. Agreement between soil quality status, for each soil threat, estimated by SQAPP and from measured soil properties.

			Agreement between classification based on **SQAPP** and from **measured properties** (same location)		
Properties	Threats	Parameter	SQAPP Agreed	Total	%
Soil Texture	Erosion	Erodibility factor	tba		
and	Susceptibility to compaction	Texture Class	**19**	37	**51**
Bulk Density	Susceptibility to compaction	Packing Density	**12**	37	**32**
SOC	SOM decline	SOC (%)	**16**	37	**43**
Soil pH	Acidification	Soil pH	**17**	37	**46**
Electrical Conductivity	Salinization	EC (dS/m)	**23**	26	**88**
Avail. P	Nutrient depletion	P (Olsen) (mg/kg)	**6**	21	**29**
Exc. K	Nutrient depletion	K (mg/kg)	**11**	33	**33**
Total N	Nutrient depletion	N (mg/kg)	**11**	33	**33**
Microbial C	Biodiversity loss	Microbial C (g/m^2)	tba		
Macrofauna	Biodiversity loss	Number	tba		

Tba: to be assessed.

Discussion

SQAPP, in the current beta version (2018), will not provide a reliable estimate, at a chosen location, for the following soil properties: bulk density, nutrient status (available P, total N and exchangeable K), macrofauna and microbial biomass C, directly affecting the ability of SQAPP to correctly identify the status of soil threats (to classify). Concerning soil electrical conductivity, the range of soils studied does not allow to draw a meaningful conclusion.

In relation to soil texture, pH and soil organic carbon, SQAPP, at a chosen location, will only provide a very rough estimate. The ability of SQAPP to correctly identify the status of soil threats that are linked to these soil properties remain low.

The ability of SQAPP to correctly classify each soil threat of a particular soil and a given location, the accuracy of a soil quality index and the pertinence of a recommendation system based on the estimates will be explored in part 2 of this report, along with recommendations for the improvement of SQAPP.

Note: Part 2 will focus on Soil Quality Index and recommendations for SQAPP.

References

Barão L. and Basch G., 2017. Selection of sites for testing ‘soil improving’ measures. Updated report on Milestone 6.1 of project iSQAPER. University of Évora.

Annex 1. Selected 24 pairs AMP-Control, CSS, climatic region and georeferenced coordinates.

CSS	CLIMATIC REGION	PLOT Nº	GEOREFERENCED coordinates		FARMING SYSTEM	FARMING SYSTEM DETAIL	SOIL TYPE	AMP Nº
The Netherlands	Atlantic	1.1	51,53948° N	5,848589° E	Irrigated land with arable and vegetable crops	Potato-pea/grassclover-leek-springbarley-carrot-silage maize (both in AMP and control)	Podzol/ Anthrosols	2
		Control	51,539474° N	5,848187° E				
		1.3	51,543047° N	5,849341° E	Irrigated land with arable and vegetable crops	Potato-pea/grassclover-leek-springbarley-carrot-silage maize (both in AMP and control)	Podzol/ Anthrosols	12
		Control	51,539442° N	5,846824° E				
France	Atlantic	2-1 AMP b	48,001360° N	1,449080° E	Arable land	Maize/cereal rotation	Cambisol	1; 9
		2-1 Control	48,070890° N	1,109390° E				
		2-3 AMP	48,068970° N	1,108080° E	Pasture intensive	Cows	Cambisol	
		2-3 Control a	48,068390° N	1,105920° E		Cows		
Portugal	Mediterranean temperate	3.2	40,237883° N	8,466333° W	Arable land	Maize	Fluvisols	8
		Control	40,220333° N	8,48125° W				
		3.7	40,422117° N	8,485689° W	Permanent crops	Vineyards	Cambissols	13
		Control	40,422667° N	8,485667° W				
Spain	Mediterranean semi-arid	4.5	38,164218° N	0,712572° W	Permanent - fruit trees and berry plantations	Pomegranate	Regosol	2; 3
		Control	38,190709° N	0,687498° W				
		4.12	37,855917° N	0,830250° W	Arable permanently irrigated	Pepper	Cambisol	9; 7
		Control	37,853980° N	0,831980° W				
Greece	Mediterranean temperate	5.9	35,320803° N	25,236560° E	Permanent crops	Olives	Regosol	1
		Control	35,321462° N	25,236689° E				
		5.12	35,295923° N	24,907333° E	Pastures	A grazing system in which the main grazing vegetation is sowed (cereals and legumes)	Cambisol	18
		Control	35,296190° N	24,907585° E		A grazing system in which the main vegetation consists of schlerophyllous, olive trees and annual natural vegetation		
Slovenia	Southern sub-continental	6.9	46,093771° N	14,495881° E	Non irrigated arable land	Organic farming with diverse rotation; manure	Cambisol	9
		Control	46,093537° N	14,495542° E		Only vegetable crops; compost		
		6.12	46,124762° N	14,495882° E	pastures	Grazing	Cambisol	18
		Control	46,124491° N	14,497139° E		Grass cutting		
Hungary	Southern sub-continental	7.1	46,788694° N	17,489417° E	Permanent crops	Vineyards	Cambisols	5; 8
		Control	46,788611° N	17,488778° E				
		7.5	46,715722° N	16,812917° E	Non irrigated arable land	Cereals; Maize; Oil crops	Luvisols	2; 8; 9; 11
		Control	46,703139° N	16,817944° E				
Romania	Northern sub-continental	8.8	45,229629° N	27,579469° E	Non irrigated arable land	Maize	Chernozems	14
		Control	45,197142° N	27,580508° E				
		8.11	45,284859° N	27,850021° E	Pastures extensive		Chernozems	18
		Control	45,304876° N	27,835111° E				
Poland	Northern sub-continental	9.1	51,993824° N	22,550696° E	Non irrigated arable land	Maize	Podzols	7
		Control	51,996773° N	22,547874° E		Cereals		
		9.3	51,313861° N	22,450944° E	Permanent crops	Hops	Cambisols	12
		Control	51,302610° N	22,422940° E				
Estonia	Boreal to sub-boreal	10.12	58,99181° N	24,871640° E	Grassland; conventional; intensive	Grassland for silage	Eutric Histosol	18

CSS	CLIMATIC REGION	PLOT Nº	GEOREFERENCED coordinates		FARMING SYSTEM	FARMING SYSTEM DETAIL	SOIL TYPE	AMP Nº
		Control	58,99232° N	24,874360° E	Non irrigated arable land; conventional	Cereals		
		10.14	58,2844° N	26,491210° E	Non irrigated arable land; conventional		loamy sand Stagnic Luvisol	2; 3; 5; 9
		Control	58,2861° N	26,493190° E				9
China - Qiyang	Central Asia tropical	11.4	26,761111° N	111,865278° E	Permanent crops		Acrisols	6; 7a
		Control	26,758333° N	111,871390° E	Permanent crops			
China - Suining	Central Asia tropical	12.1	30,613067° N	105,022033° E	Arable land	Maize-Wheat rotation	Plaggic Anthrosols (Eutric)	8
		Control	30,613067° N	105,022033° E				
China - Gongzhuling	Middle Temperate	14.1	43,6125° N	124,794440° E	Non irrigated arable land		Phaeozems	8
		Control	43,6125° N	124,794440° E				
		14.4	45,258333° N	124,896389° E	Irrigated arable land		Chernozem	8; 14
		Control	45,262778° N	124,875560° E				

Annex 2. Required information for soil quality assessment.

Main Group	Group	Fields
General farm, plot and management information	General farm Information	• Plot location (CSS) • Plot number (in iSQAPER) • Researcher responsible for the collection/analysis • Contact email • Phone contact
	General plot information, land use and agricultural measures	• Plot centre coordinates • Plot area [ha] • Slope angle [%] • Slope length [m] • Do you expect heavy metal contamination in your plot? • If yes, what is the source? • If yes: Which heavy metal contamination (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) do you expect? • Do you expect pesticide contamination in your plot? • Is there an input of manure / slurry / sludge in your soils? • If yes: is there any analysis of heavy metal content? • If there's an input of manure/ slurry/ sludge: Please provide details concerning the type applied and the amount [kg ha-1]. • Is salinity or any other soil crust/hardpan inducing source a problem in your plots? • If yes, please mention the source of soil salinity, and whether or not it induces a soil crust, and hardpans you may encounter in the profile. • Do you use plastic mulch in your soils? • If yes: Please describe the plastic mulch management. • Number of stone walls in the plot. • Number of grass margins / stripes in the plot. • Is there any contour farming measure? • If yes: please describe the contour farming measure. • What is the importance of soil threats in your plot? (8 threats to be evaluated) • What is the farming system? **Arable Land:** • Please indicate the main three crops / plants in your rotation. • Please indicate more details of the actual or the normal crop rotation in your plot relevant for 2018. • Tillage type. • If your tillage practice is not in the list, please name it. • Tillage frequency per year. • Tillage depth [cm]. • Secondary soil tillage type. • Secondary soil tillage frequency per year. • Fate of plant residues for the cropping season of 2018. Type of plant residues. • Amount left [t ha-1]. • Percentage of soil covered [%]. • Cover crops during winter? • Cover crop (specie). If it's a mixture (species). • Sowing date (dd-mm-yyyy) • End date (date of the final intervention (cut, burried, etc)) • Percentage of soil covered [%] • Approx. biomass left [t DM/ha] **Non-arable system:** • Details of the farming system: Plants species; management practices. • Percentage of soil covered by crop canopy. • Percentage of soil covered by other vegetation.

Soil examinations, soil properties	Soil physical properties	• Is there anything particular about the soil at your testing site? If Yes: please mention them. • Estimation of the stone content. Granules and pebbles (2-64 mm). Cobbles (64-256 mm). Boulders (>256 mm). Form of the stones. Content in [Vol.-%] >2mm. • Soil texture. Sand [%] (2 - 0.1 mm). Fine Sand [%] (0.1 - 0.05 mm). Silt [%] (0.05-0.002 mm). Clay [%] (< 0.002 mm). • Bulk density [t m-3]. • Soil Structure.
	Soil biological properties	• Microorganisms Carbon Content [g kg-1]. • Number of different co-occurring soil macro fauna groups.
	Soil chemical properties	• OM content [%]. • pH (CaCl2). • Electrical conductivity [dS m-1]. • Total N (mg kg-1 of soil). • Total P (mg kg-1 of soil). • Extractable P (mg kg-1 of soil). • Extractable K (mg kg-1 of soil). • Heavy Metals (mg kg-1 of soil): As, Cd, Cr, Cu, Hg, Ni, Pb, Zn.

Annex 3. Thresholds for soil quality assessment (adapted).

SOIL THREAT and indicator		THRESHOLDS			
Soil erosion by water					
Soil loss (t/ha/year)		0-2	2-10	>10	
Vulnerability (class)		low	medium	high	
Soil erosion by wind					
Soil loss (t/ha/year)		0-0.5	0.5-3	>3	
Vulnerability (class)		low	medium	high	
Soil compaction					
Natural susceptibility		low	medium	high	
Soil salinisation					
Electrical conductivity (dS/m)		0-2	2-4	>4	
Soil organic matter decline					
Soil organic carbon content (%)		0-1	1-2	>2	
Soil nutrient depletion					
Exchangeable K (cmol/kg)		0-0.2	0.2-0.3	>0.3	
Available P (Olsen method) (mg/kg)	--> see note	0-20	20-40	>40	
Total N (g/kg)		0-1	1-2	>2	
Soil acidification					
Soil pH	<5.5	5.5-6.5	6.5-7.5	7.5-8	>8
Soil contamination					
Arsenic (mg/kg)		0-37.5	37.5-50	>50	
Cadmium (mg/kg)		0-2.25	2.25-3	>3	
Chromium (mg/kg)		0-300	300-400	>400	
Copper (mg/kg)	pH <5.5	0-60	60-80	>80	
	pH 5.5-6.0	0-75	75-100	>100	
	pH 6.0-7.0	0-101.3	101.3-135	>135	
	ph >7.0	0-135	135-200	>200	
Lead (mg/kg)		0-225	225-300	>300	
Mercury (mg/kg)		0-0.75	0.75-1	>1	
Nickel (mg/kg)	pH <5.5	0-37.5	37.5-50	>50	
	pH 5.5-6.0	0-45	45-60	>60	
	pH 6.0-7.0	0-56.25	56.25-75	>75	
	ph >7.0	0-82.5	82.5-110	>110	
Zinc (mg/kg)		0-150	150-200	>200	
Soil biodiversity					
Soil biodiversity index		low	medium	high	

Annex 4. Soil threat status classification and distribution by classes, from estimated and measured values (37 fields).