Preliminary outcomes of EJP SOIL WP6

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Preliminary outcomes of EJP SOIL WP6

19 October 2021 EUSO Stakeholders forum

14:00 Core EUSO Objective: Integrated soil monitoring

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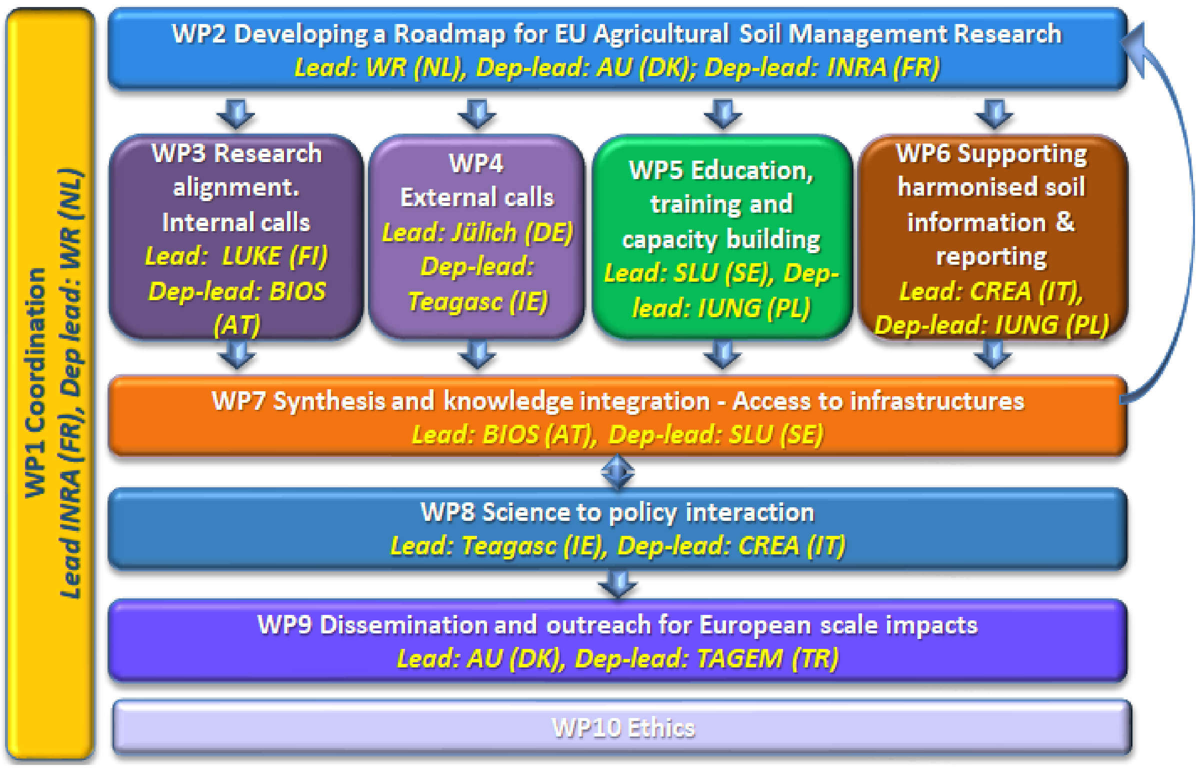
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

EJP SOIL PROJECT AND THE WP6



WP6	
TASK 6.1 BASIC DATA STANDARDIZATION HARMONIZATION	TASK 6.2 THEMATIC LAYERS SOIL BASELINE
TASK 6.3 SOIL MODELING SOIL INDICATORS TARGET VALUES SOIL MONITORING	TASK 6.4 SOIL MONITORING IN FIELD PROXIMAL/REMOTE SENSING

The **overall goal of the EJP SOIL** is to build a sustainable European integrated research system on agricultural soils and develop and deploy a reference framework on climate-smart sustainable agricultural soil management.

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TASK 6.3 topics and aims

- Define, calculate and map indicators for soil health, threats and soil-related ecosystem services in close collaboration with JRC, EEA and EJP-SOIL internal projects

- Identify soil monitoring issues across EJP SOIL partners and JRC (to update national/EU monitoring campaigns as LUCAS)

- Contribute to a common ground for the future EU soil monitoring system (EU and national collaborations) in link with EUSO

T6.3 Activities

- Collaborate with LUCAS 2022 campaign to define/identify additional sampling points
- Stocktake the description of monitoring networks across EJP SOIL partners through the use of a questionnaire (20 answers, 41 contributors)
- Publish a deliverable (24 writers from 15 countries), under revision
  - State of the art
  - Review of existing soil monitoring systems based on the questionnaire (country by country)
  - Transversal analysis of the answers
  - Main deviations identified and possible ways of harmonization
  - Recommendations for the next steps
  - Conclusions


Rubrique 1 sur 12

WP6 - Supporting harmonised soil information and reporting
Task 6.3 - Agricultural potential and sustainable values of SOC, agricultural soil fertility and degradation

AIM OF THE QUESTIONNAIRE
Within EJP-SOIL, WP6 is dedicated to the harmonisation of data (from collection to use), data exchange and data treatment (e.g. mapping). WP6 is analysing the existing data in all EJP-Soil countries and is providing guidance for the future collection, storage, exchange and use of soil data (e.g. to produce new information).

WP6 is collaborating with EU structures dealing with soil information (mainly JRC-ESDAC, but also DG Env, DG Agri and DG Climate) and in particular in the activities related to the development of the next fore coming LUCAS soil campaigns (in 2022 and others) and of the EU Soil Observatory (https://ec.europa.eu/jrc/en/eu-soil-

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Towards climate-smart sustainable management of agricultural soils

Deliverable 6.3
Proposal of methodological development for the LUCAS programme in accordance with national monitoring programmes

Due date of deliverable: M18
Actual submission date: 31.07.2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 862695 1

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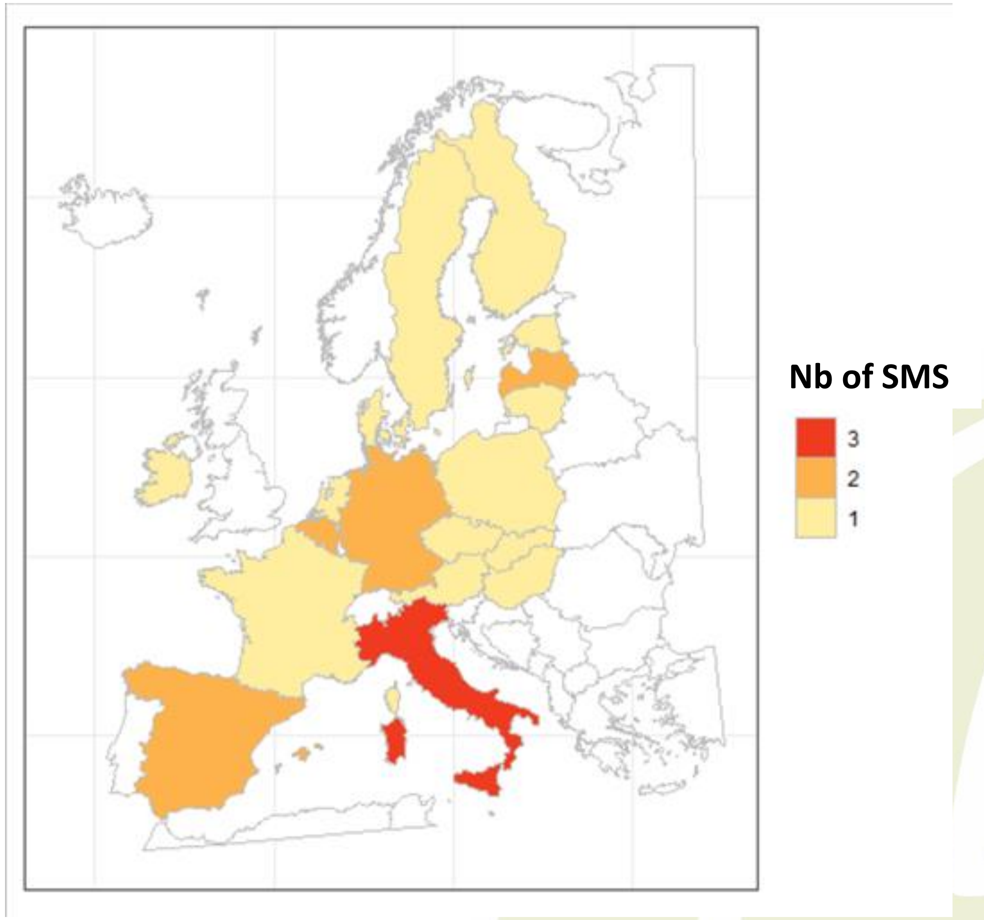
Transversal analysis – SMS in EJP SOIL countries

- 20 countries answered out of 24 (ending with 27 declared SMS)
- Turkey and Portugal do not have SMS
- Five countries have 2 or 3 monitoring systems
  - SMS managed at regional scale
  - SMS with different purposes (e.g. agricultural *vs* forest, monitoring trace element *vs* agricultural parameters, monitoring a network of highly instrumented sites *vs* network agricultural soils)
- Caution: Not all countries declared their forest SMS



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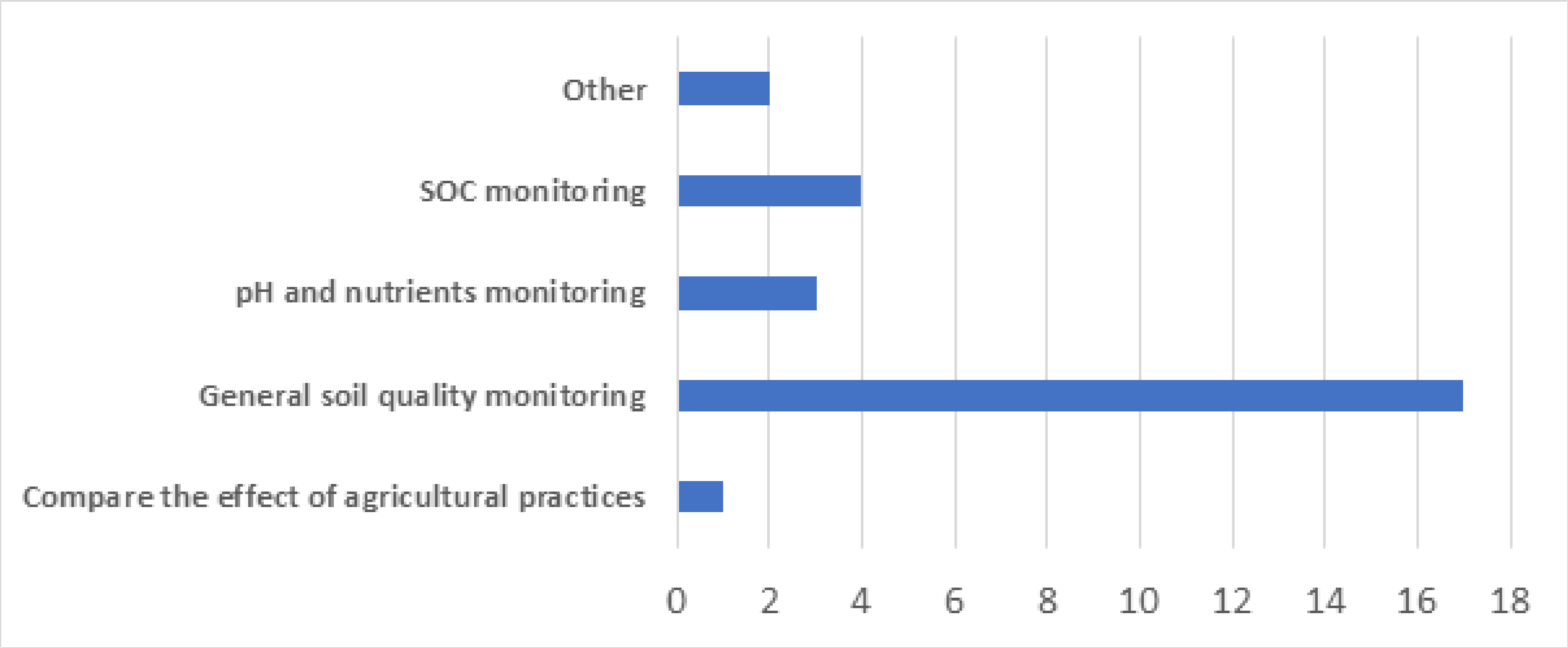
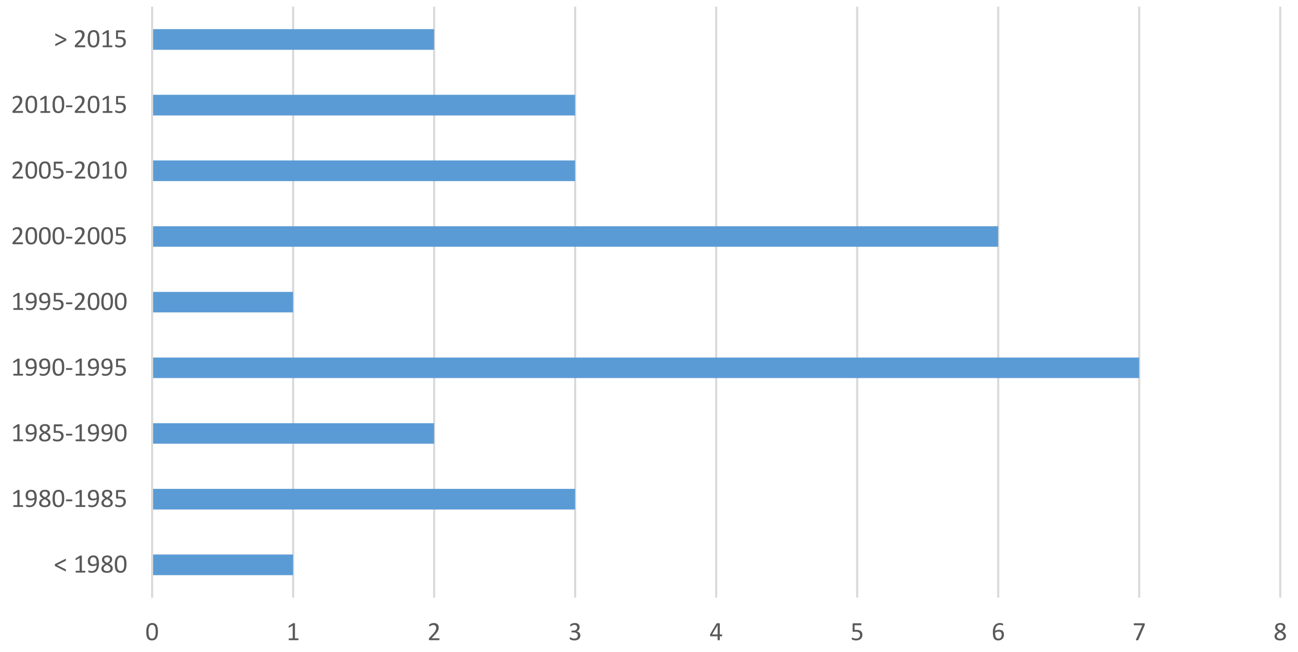
Transversal analysis – Main objective of SMS



Transversal analysis – Starting dates



Starting dates

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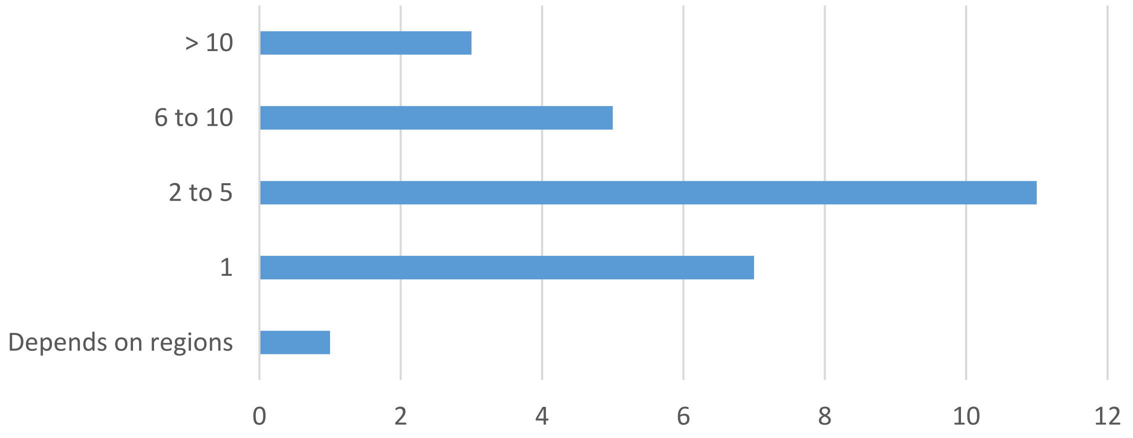
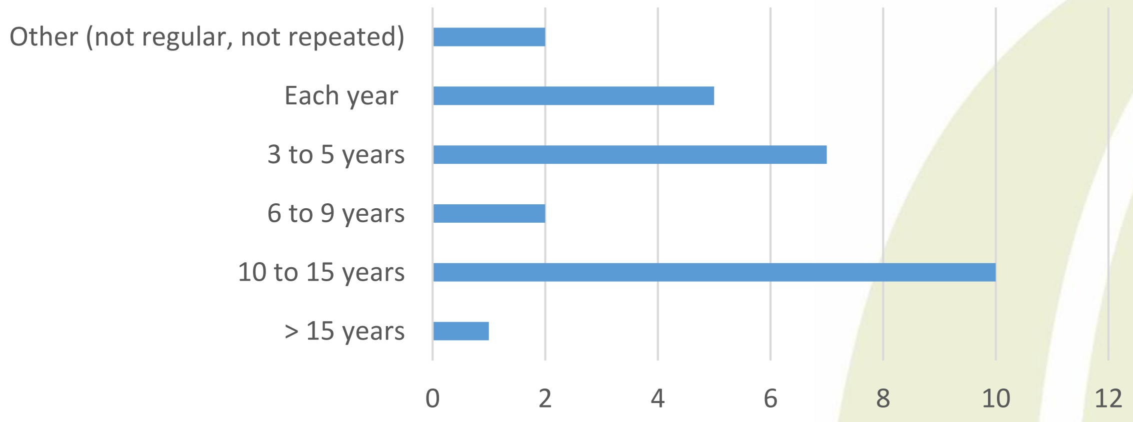
Transversal analysis – Number of campaigns completed and interval between each campaign



Number of campaigns



Interval between 2 campaigns

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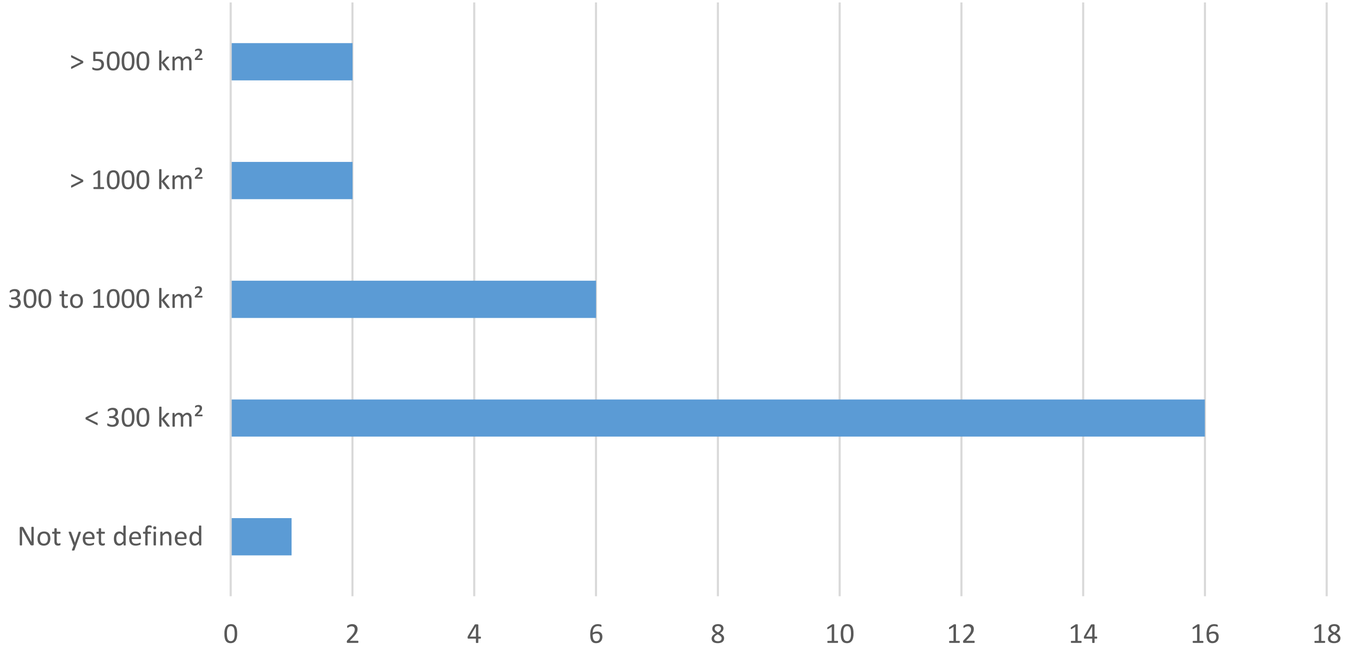
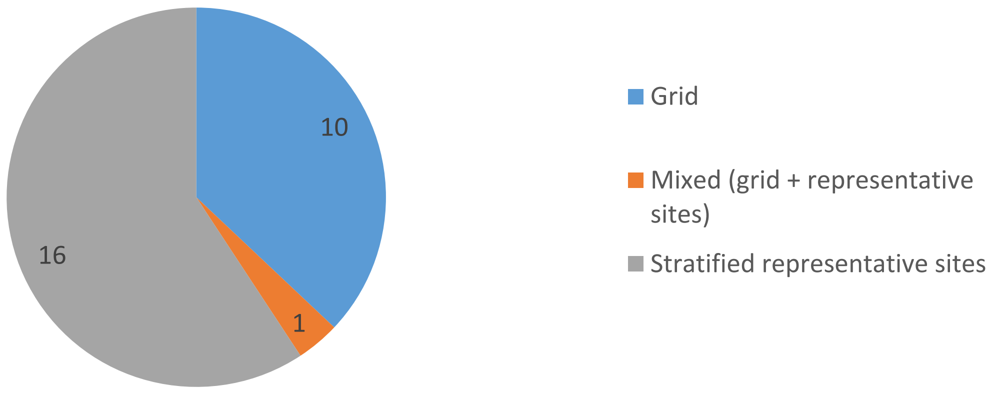
Transversal analysis – Density of sites



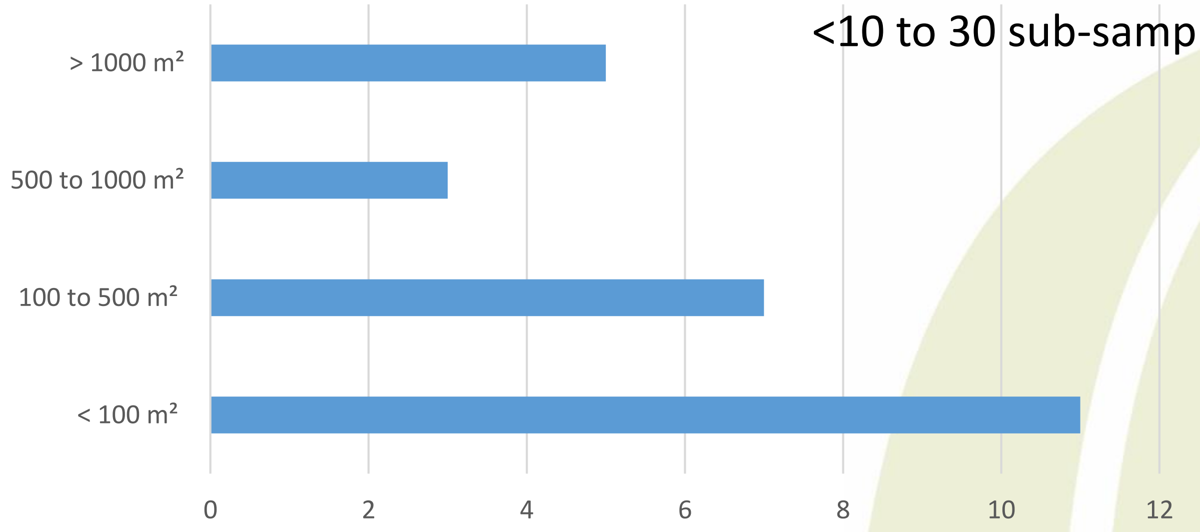
Density of sites

Transversal analysis – Sampling strategy and sampling area



Sampling design

Composite sampling (from <10 to 30 sub-samples)



Sampling area

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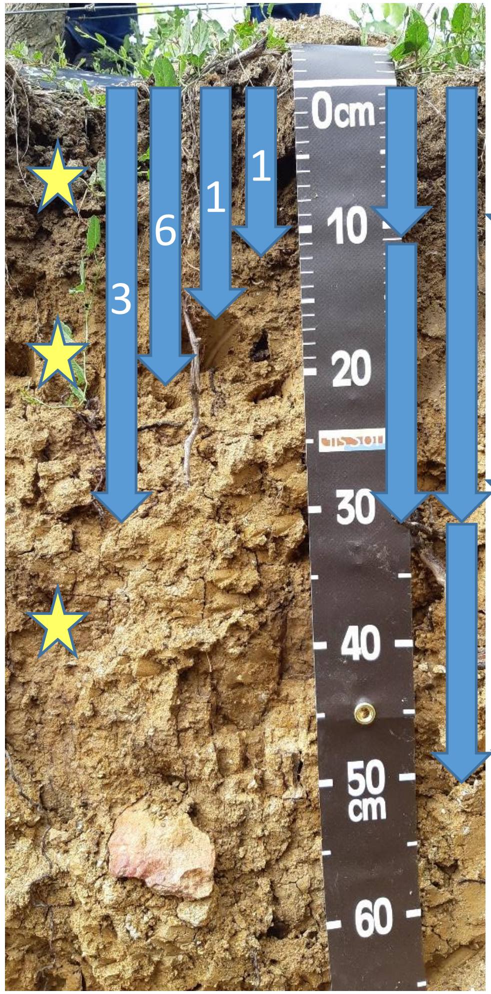
Transversal analysis – Sampling depth



11 one fixed depth

16 MS sample for bulk density

4 according to horizons

14 different fixed depths

13 MS are sampling deeper than 30 cm

to 1 m

Analytical methods (to be completed)

	Countries	Sweden	France	EU-JRC	Czech Republic	Latvia		Lithuania	Belgium - Wallonia	Belgium - Flanders	Netherlands	Slovakia	Denmark	Germany	TOTAL
	Name of the Soil Monitoring System	Soil & Crop Inventory	RMQS	LUCAS[a]	Basal soil monitoring	SPPS	SPPS N	Dirv_DR10LT	CARBIOSOL	Koolst of monitoring netwerk	Netherlands Soil Sampling Program (NSSP)	CMS-P	DSMDB	Boden-Dauerbeobachtung[b]	
Main soil properties, according to Global Soil Map specifications, 2015	total profile depth		x					x		x	x	x		x	6
	plant exploitable (effective) soil depth		x					x			x			x	4
	organic carbon	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**13**
	pH in water	**x**	**x**	**x**		**x**	**x**	**x**		**x**	**x**	**x**		**x**	**10**
	sand	**x**	**x**	**x**	**x**	**x**		**x**		**x**	**x**	**x**		**x**	**10**
	silt	**x**	**x**	**x**	**x**	**x**		**x**		**x**	**x**	**x**		**x**	**10**
	clay	**x**	**x**	**x**	**x**	**x**		**x**		**x**	**x**	**x**		**x**	**10**
	gravel		x	x				x		x	x	%		x	6
	ECEC	x	x	x	x	x	x	x				x		x	9
	bulk density of the fine earth (< 2 mm) fraction (excludes gravel)		x						x	x	x			x	5
	bulk density of the whole soil in situ (includes gravel)		x	x	x			x			x	x		x	7
	available water capacity							x						x	2
	Electrical Conductivity		x			x		x			x	x		x	6
Other soil properties	**calcium-carbonate content**	**x**	**x**	**x**	**x**	**x**	**x**	**x**		**x**		**x**		**x**	**10**
	Field capacity (mm)							x						x	2
	Plant available amounts of macro and micro nutrients	**x**	**x**	**x**	**x**	**x**	**x**	**x**		**x**	**x**	**x**	**x**	**x**	**12**
	Total amounts of macro and micro nutrients/trace elements	x	x	x	x	x		x					x	x	8
	quality of clay minerals (e.g. type or ratio of illite, smectite, montmorillonite in clay fraction...etc)			x				x							2
	distribution of soil organisms		x	x							x		x	x	5
	properties for NIR and MIR (near and mid infrared)	x	x	x						x	x				5

Harmonization options

Questions	Yes		No	
	#	Representative comments	#	Representative comments
May the sampling design of your SMS be adapted or changed?	15	- New sites are possible (#12) - We are planning a new SMS, changes can occur (#3)	13	- Changing design would make it impossible to compare the data with the old samples - Changes in the design would affect the time series in the core sampling area.
Can you consider collecting new information on the monitoring sites?	23	- Depends on means - Soil management information will improve the use of data	4	- It takes too much time - Financial support needed
Can the soil description be improved?	16	- Translation of national classification into WRB can be made - If there is new funds soil description/classification can be made	11	- Not planned - Needs skilled people - Too much time/work on the site
Can you modify the sampling area?	7	- We are planning a new SMS, changes can occur (#3)	19	- Rather no, all the previous data rely on this protocol. - Changing the area would make it impossible to compare the data with the old samples
Can you change the sampling depths?	8	- We may sample deeper (#4) - We are planning a new SMS, changes can occur(#3)	17	- All previous data rely on this protocol
Can you change the soil sample preparation, before analysis?	5	- We are planning a new SMS, changes can occur (#3)	20	- All previous data rely on this protocol
Can you change measurement methods?	9	(without comment)	15	- Since the purpose is to monitor changes, changes in the measurement methods is problematic - Would probably need some double analysis, which means increased costs.
Can you add extra parameters to be analysed?	20	- Depending on funds (struggling to maintain basic analysis)	4	- Costs

D6.3. Recommendations

- Compare national and LUCAS sampling strategies/schemes (develop the same approach)
- Compare national data with LUCAS data, country/country (develop the same approach)
- Develop transfer functions (from sampling to analytical methods), taking the opportunity of LUCAS 2022
- Identify / test methods to merge national and LUCAS datasets or existing maps
- Develop interpretation values/scoring approaches

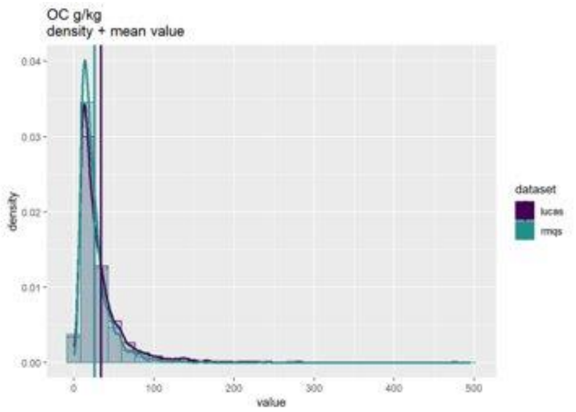
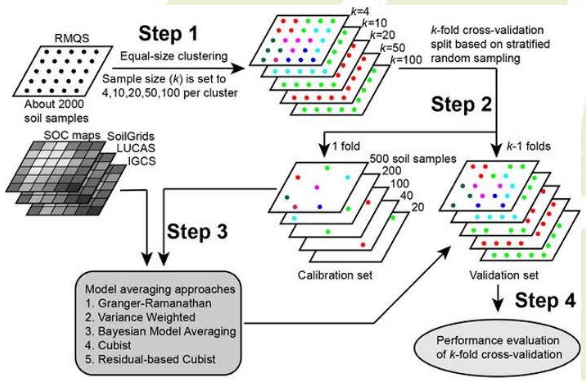


Table 3. Equations of PTFs built by partial least square regression (PLSR) for estimating Olsen P_2O_5 with their mean R^2 and RMSE values based on cross-validation.

R^2	RMSE (mg kg^{-1})	Equations
PTFs built with Joret-Hébert P_2O_5 and other variables		
0.398 a	33.719aa	Olsen P_2O_5 = 27.215 + 0.244*Joret-Hébert P_2O_5
0.535b	29.627bb	Olsen P_2O_5 = -19.619 + 0.254*Joret-Hébert P_2O_5 + 0.096*Silt
0.535b	29.630bb	Olsen P_2O_5 = 299.664 + 0.270*Joret-Hébert P_2O_5 – 35.208*pH_{water}
0.608c	27.198 cc	Olsen P_2O_5 = 218.385 + 0.263*Joret-Hébert P_2O_5 – 29.419*pH_{water} + 0.079*Silt
PTFs built with Dyer P_2O_5 and other variables		
0.638d	27.860dd	Olsen P_2O_5 = 28.315 + 0.19*Dyer P_2O_5
0.681d	26.167dd	Olsen P_2O_5 = 21.5 + 0.193*Dyer P_2O_5 + 35.49*exchangeable Al
0.659d	27.062dd	Olsen P_2O_5 = 63.246 + 0.195*Dyer P_2O_5 – 6.063*pH_{water}
0.685d	25.985dd	Olsen P_2O_5 = 57.522 + 0.193*Dyer P_2O_5 – 5.987*pH_{water} + 35.447*exchangeable Al

Note: R^2 means coefficient of determination, RMSE means root mean-square error; "a","b","c",d","aa", "bb", "cc" and "dd": letters indicating significant differences from mean comparison ($\alpha \leq 5\%$) of R^2 and RMSE among PTFs.



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Compare LUCAS/national sampling schemes and datasets

- Sampling schemes (D6.1)
  - Not one best sampling design: depends on the objective (e.g. produce mean, identify variations, map a parameter, develop classes…)
  - When adding or combining two campaigns, the design and inclusion probabilities need to be known
  - Comparison of sampling designs is needed country by country, based on the same approach
- Datasets
  - Identify a set of relevant parameters,
  - Compare the results, country by country, at country level and at land use level…
  - Identify/explain possible variations (e.g sampling designs/methods, analytical procedures…)

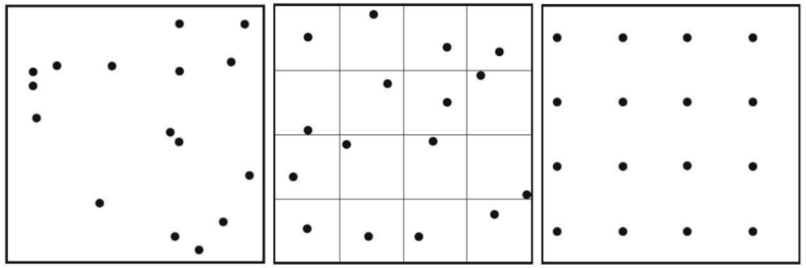
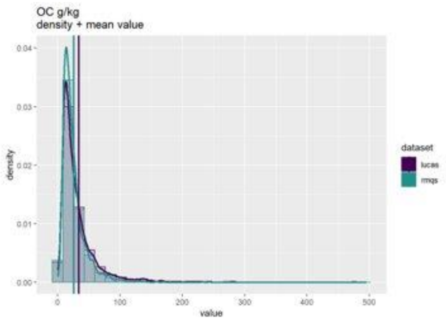
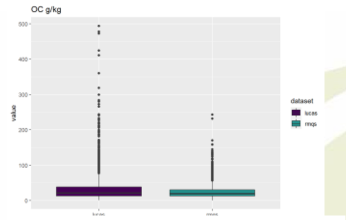
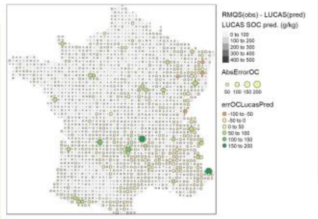
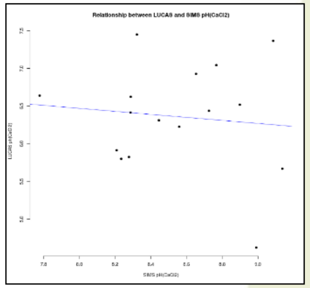


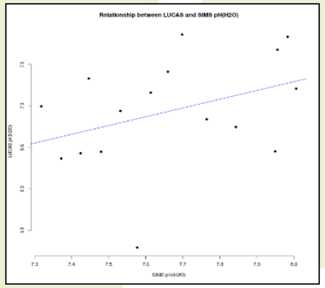
Figure 4.1 National examples of sampling patterns based on simple random sampling (left), stratified random sampling (middle), systematic random sampling (right). Adapted From De Gruijter et al. (2006).











Develop transfer functions (from sampling to analytical methods)

- Compare analytical methods
  - E.g. pH KCl/water, OC methods… across countries
  - Develop transfer functions to use soil data (LUCAS method being the "reference")

- Compare the entire procedure (from sampling to analyze)
  - Double sampling needed (done in Austria)
  - Take the opportunity of LUCAS 2022
  - Develop transfer functions (LUCAS method being the "reference")

Table 1. Comparison between the sampling devices and soil analyses of Biosoil and RMQS.

	RMQS	Biosoil	Comparison
Network	16 km × 16 km grid	16 km × 16 km grid	=
Sampled layers	0–30 cm	0–10 cm, 10–20 cm	≠
		and 20–40 cm	
Organic carbon	Dry combustion	Dry combustion	=
	NF ISO 10694	ISO 10694:1995	
Potassium	HF & $HClO_4$ (total)	HF & $HClO_4$ (total)	=
	NF X31-147 ICP-MS	ISO 14869-1:2001	
Lead	HF & $HClO_4$ (total)	Aqua regia (incomplete)	≠
	NF X31-147 ICP-MS	ISO 11466:1995 mod.	
pH	Suspension in 1/5 of water	Suspension in 1/5 of water	=
	NF ISO 10390	ISO 10390:1994	

B.P. Louis, N.P.A. Saby, T.G. Orton, E. Lacarce, L. Boulonne, C. Jolivet, C. Ratié, D. Arrouays. 2014. **Statistical sampling design impact on predictive quality of harmonization functions between soil monitoring networks**. Geoderma, Volume 213, 2014, Pages 133-143. https://doi.org/10.1016/j.geoderma.2013.07.018.

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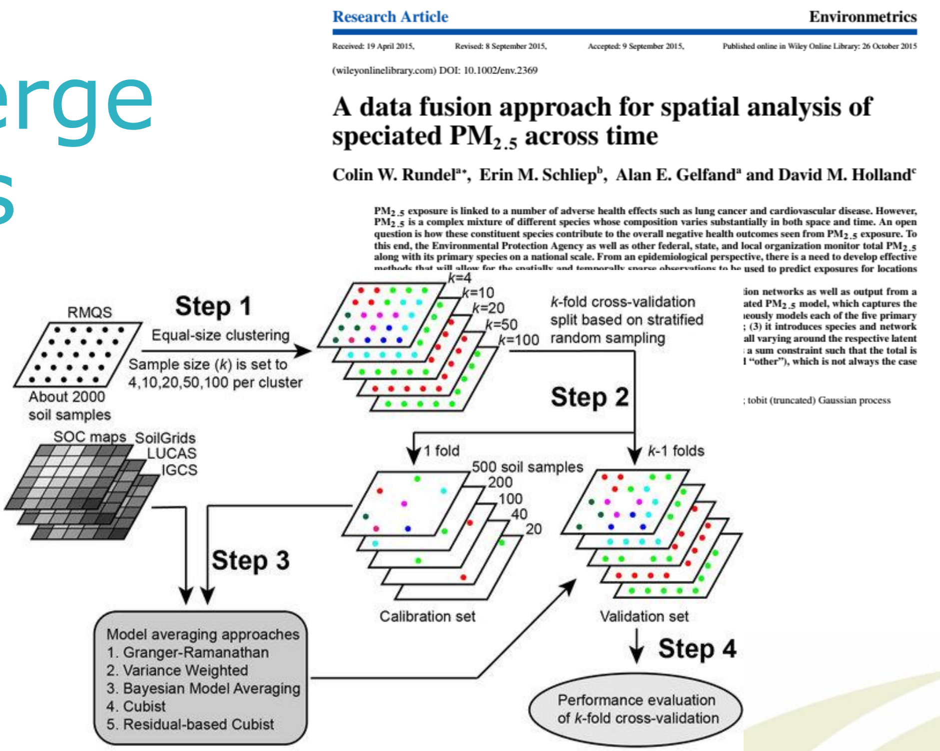
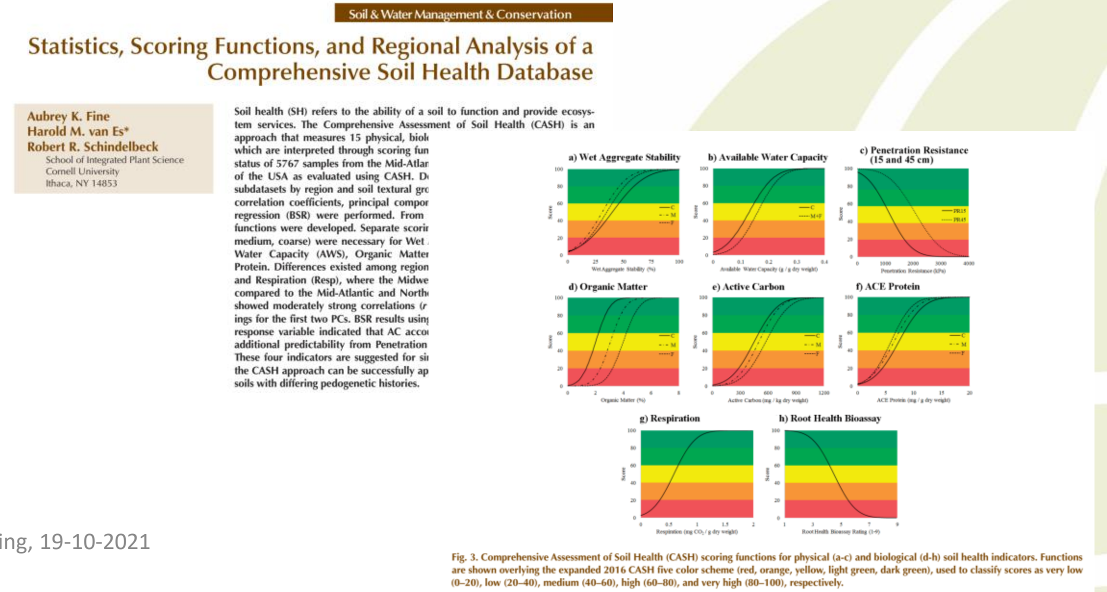
Identify and test methods to merge datasets/maps and score results

- Identify / test methods to merge national and LUCAS datasets or existing maps

- Develop interpretation values/scoring approaches to use data produced with different protocols





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Next steps

- Revise/update the Deliverable D6.3 and publish the document
- Harmonization will be difficult (nor impossible) as several SMS are currently running for more than 20 years and changing protocols will impact the use of previous data from existing campaigns (it may be an option for countries defining their SMS …)
- Proposals were made to take benefit of existing systems and will be tested within EJP SOIL
  - Quite all EJP SOIL partners will compare according to the same approach,
    - National and LUCAS sampling strategies/schemes
    - National and LUCAS datasets/results
  - Several partners will also
    - Develop transfer functions (from sampling to analytical methods), taking the opportunity of LUCAS 2022
    - Identify / test methods to merge national and LUCAS datasets or existing maps
    - Develop interpretation values/scoring approaches (in link with other EJP SOIL projects)