

# LANDMARK SESSION: SOIL MANAGEMENT, MONITORING AND UNDERSTANDING THE SUPPLY AND DEMAND OF SOIL FUNCTIONS AT A EUROPEAN SCALE

Rachel Creamer (WUR)

## What Approach, results and key messages

LANDMARK invited stakeholders to discuss with project partners the state-of-the art knowledge and EU research needs in the context of the **LANDMARK** past 30 months activities.

Session outline:

Chair: Prof Rachel Creamer (**Wageningen University & Research**)

- Introducing LANDMARK H2020 by the project coordinator Prof Rachel Creamer (**Wageningen University & Research**)
- Stakeholder engagement: harvesting existing knowledge on soil quality and soil functions (**WP1**) by Dr **Francesca Bampa (Wageningen University & Research)**
- Monitoring soil quality and functions (**Pillar2**) by Dr **Jeroen van Leeuwen (Wageningen University & Research)**
- EU policy tools for optimizing soil functions and Functional Land Management (**Pillar3 & WP4**) by Dr **Jan Staes (Antwerp University)**
- LANDMARK Strategic Research Agenda (**WP1**) by Prof Rachel Creamer (**Wageningen University & Research**)
- Discussion and conclusions

## More Further reading

Web: <http://landmark2020.eu/>

Twitter: <https://twitter.com/landmark2020>

Facebook: <https://www.facebook.com/LandmarkH2020/>

LinkedIn: <https://ie.linkedin.com/in/landmark2020>

Vimeo: <https://vimeo.com/landmark2020>

Email: [info.landmark@wur.nl](mailto:info.landmark@wur.nl)

# SOIL MANAGEMENT, MONITORING AND UNDERSTANDING THE SUPPLY AND DEMAND OF SOIL FUNCTIONS AT A EUROPEAN SCALE

06<sup>th</sup> December 2017

WORLD SOIL DAY 2017 – Land, Soils and Science,

IBGE, BRUXELLES



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635201.

## AGENDA

### LANDMARK session chaired by Prof Rachel Creamer (WUR)

10.00 -10.20	<b>INTRODUCTION</b> by <i>LANDMARK coordinator Prof Rachel Creamer (WUR)</i>	
10.20 – 10.40	<b>Stakeholder engagement: Harvesting existing knowledge on soil quality and soil functions</b> by <i>Dr Francesca Bampa (WUR)</i>	
10.40 – 11.00	<b>Designing, testing and evaluating a monitoring schema for soil functions</b> by <i>Pillar2 postdoc Dr Jeroen van Leeuwen (WUR)</i>	Regional
11.00 – 11.20	<b>Functional Land Management at European level: demands on soil functions and scenario analyses</b> by <i>Pillar3 Dirk Vrebos &amp; Jan Staes (University of Antwerp)</i>	European
11.20 – 12.00	<b>DISCUSSION</b>	

## TOUR DE TABLE

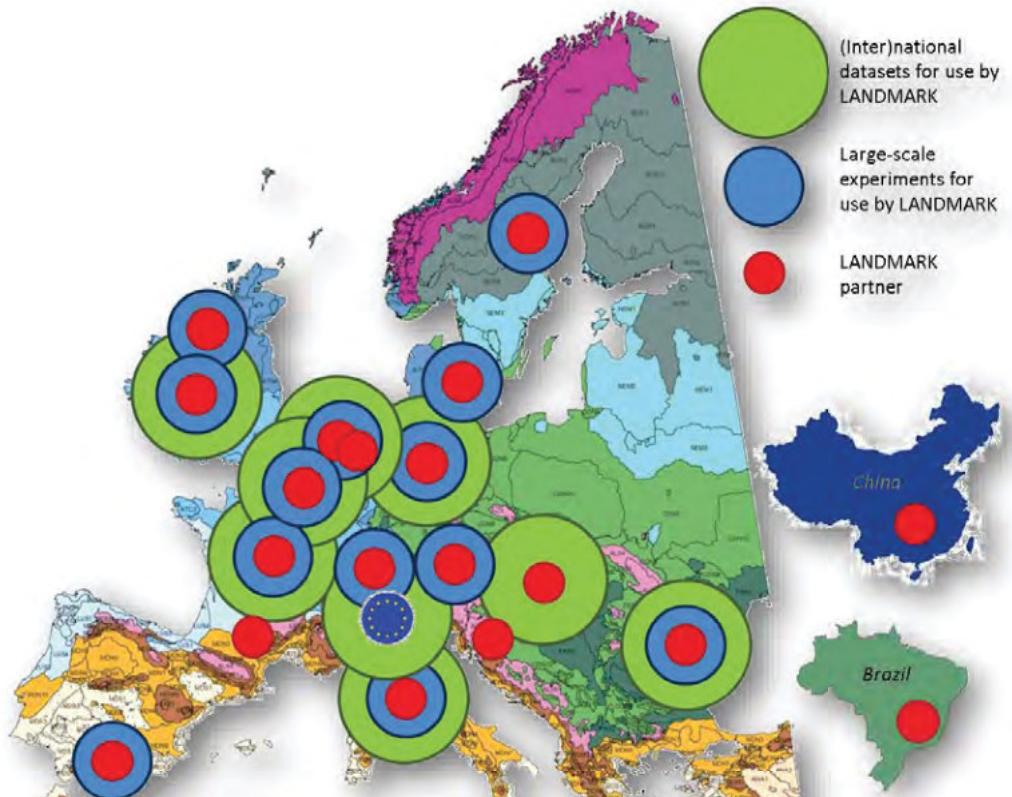


# INTRODUCTION LANDMARK

# PROJECT COORDINATOR: PROF. RACHEL CREAMER



# LANDMARK CONSORTIUM (635201)



Introduction

Knowledge

Regional

European

Discussion



[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

5

18/04/2018



## WHAT CAN OUR LAND SUPPLY?

All soils / land perform all functions...

- Habitat function
- Nutrient cycling

Strategy:

fuel

...but different parts of the land(scape) are better at delivering different functions



ENVIRONMENTAL SCIENCE & POLICY 35 (2014) 4  
Available online at [www.sciencedirect.com](http://www.sciencedirect.com)  
ScienceDirect



CrossMark

**Functional land management: A framework for managing soil-based ecosystem services for the sustainable intensification of agriculture<sup>a</sup>**

Rogier P.O. Schulte<sup>a,1,\*</sup>, Rachel E. Creamer<sup>a</sup>, Trevor Donnellan<sup>b</sup>,  
Niall Farrelly<sup>c</sup>, Reamonn Fealy<sup>d</sup>, Cathal O'Donoghue<sup>b</sup>,  
Daire O'hUallachain<sup>a</sup>

<sup>a</sup>Teagasc – Crops, Environment and Land Use Programme, Johnstown Castle, Wexford, Ireland

<sup>b</sup>Teagasc – Rural Economy Programme, Athenry, Ireland

<sup>c</sup>Teagasc – Crops, Environment and Land Use Programme, Athenry, Ireland

<sup>d</sup>Teagasc – Spatial Analysis Unit, Ashtown, Ireland

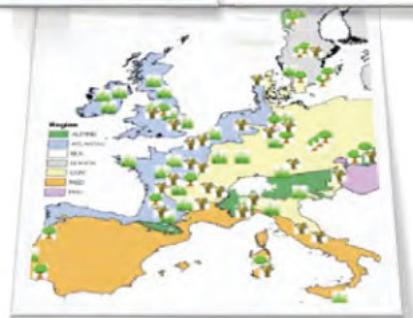


# MAIN PILLAR (WP5) OUTCOMES

**Pillar 1: Farm scale:** Develop an agricultural Decision Support Tool (DST) for soil management



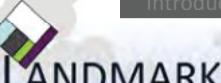
**Pillar 2: Country scale:** Design a monitoring scheme for Soil Functions that is applicable at regional scale, for a range of soil types, land uses and pedo-climatic zones;



**Pillar 3: EU scale:** Develop a policy framework for 'Functional Land Management' at European scale that aims to optimise the sustainable use of Europe's soil resource



Introduction | Knowledge | Regional | European | Discussion



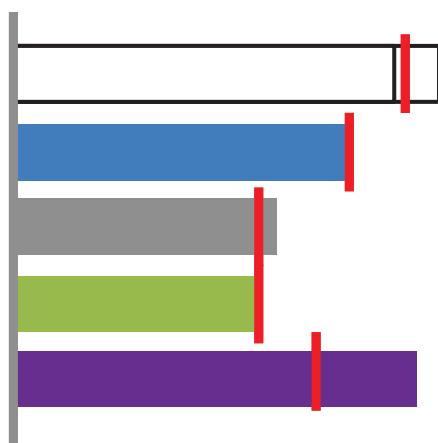
[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018



## PILLAR 1: FARM SCALE

### THE SOIL NAVIGATOR: INTERFACE



#### Recommendations:

- Buffer strips
- Nutrient management plan
- Minimum tillage
- Lime application

More info: <http://landmark2020.eu/pillars/soil-navigator-pillar1/>

Introduction | Knowledge | Regional | European | Discussion



[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

[www.inspiration-agenda.eu](http://www.inspiration-agenda.eu)

18/04/2018



# PILLAR 2: REGIONAL SCALE- MONITORING



**IOPscience** Journals Books Publishing support Login Search IOPscience.com

**Environmental Research Letters**

**ACCEPTED MANUSCRIPT • OPEN ACCESS**

**Gap assessment in current soil monitoring networks across Europe for measuring soil functions**

Jeroen P van Leeuwen<sup>1</sup>, Nicolas Saby<sup>2</sup>, Arwyn Jones<sup>3</sup>, Geertrui Louwage<sup>4</sup>, Erika Michel<sup>5</sup>, Michiel Rutgers<sup>6</sup>, Rogier P.O. Schulte<sup>7</sup>, Adelheid Spiegel<sup>8</sup>, Gergely Tóth<sup>9</sup> and Rachel Creamer<sup>10</sup>

Accepted Manuscript online 22 November 2017 © 2017 The Author(s). Published by IOP Publishing Ltd

**What is an Accepted Manuscript?**

Accepted Manuscript PDF

More info

<http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>

LANDMARK

Introduction | Knowledge | **Regional** | European | Discussion

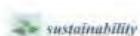
9

[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018

# PILLAR 3: EU POLICY OPTIONS

More info:  
<http://landmark2020.eu/pillars/eu-policy-tools-optimising-soil-functions-pillar3/>



## The Impact of Policy Instruments on Soil Multifunctionality in the European Union

Dirk Verbeek<sup>1,\*</sup>, Francesca Rampa<sup>2</sup>, Raquel E. Crutzen<sup>3</sup>, Ciro Gardi<sup>4</sup>, Bhim Bahadur Arwyn Jones<sup>5</sup>, Michael Rutgers<sup>6</sup>, Tariq Sandhu<sup>7</sup>, Jan Stas<sup>8</sup> and Patrick Meire<sup>9</sup>

<sup>1</sup> Ecosystem management research group, Department of Biology, University of Antwerp, Universiteitsplein 1, B-2610 Antwerpen, Belgium; jan.stas@uantwerpen.be (J.S.); patrick.meire@uantwerpen.be (P.M.)

<sup>2</sup> Crop Environment and Land Use Programme, Tongye, Wevelgem, Limburg, Flanders, Belgium

<sup>3</sup> Soil Biology and Water Soil Quality, Wageningen University and Research, 6700 AA Wageningen, The Netherlands; rama@wur.nl

<sup>4</sup> Animal and Plant Health Agency, European Food Safety Authority (EFSA), Via Carlo Magno 43/35 Trieste, Italy; ciro.gardi@efsa.europa.eu

<sup>5</sup> Department of Plant and Environmental Sciences, Faculty of Science, University of Copenhagen, Halskovsgade 14-16, DK-2100 Copenhagen, Denmark; bhm@køs.ku.dk

<sup>6</sup> FAO/CMS, Central Mean Service, Rome, Sustainable Resources Directorate, Land and Water Division, 2749, 00160 Rome, Italy

<sup>7</sup> National Institute for Public Health and the Environment, Bilthoven, Antonie van Leeuwenhoeklaan 9, 3721 MA Bilthoven, The Netherlands; michael.rutgers@rivm.nl

<sup>8</sup> Austrian Agency for Health and Food Safety—AGES, Department for Soil Health and the Soil Protection Institute, 1100, 1220 Wien, Austria; jana.sandhu@ages.at

\*Correspondence: dirk.verbeek@uantwerpen.be; Tel.: +32-3-265-67-29

Academic Editor: Miriam Tronetti Received: 20 January 2017; Accepted: 2 March 2017; Published: 9 March 2017

**Abstract:** Agricultural ecosystems provide a range of benefits that are vital to human well-being [1]. These benefits are dependent on several soil functions that are affected in different ways from the European Union, national, and regional levels. We evaluated current EU soil-related legislation and examples of regional legislation with regard to direct and/or indirect impacts on five soil functions: the production of food, fiber, and fuel; water purification; carbon sequestration; and climate regulation; habitat for biodiversity preservation; and/or nutrient/agro-chemicals. Our results illustrate the diversity of existing policies at interactions present between different spatial and temporal scales. The impact of positive or negative, on a soil function is usually not established, but depends on it is implemented by local authorities and the farmers. This makes it difficult to extract static and trends of the different soil functions in agricultural ecosystems. To implement management and sustainable use of the different soil functions in agricultural ecosystems knowledge is needed on the policy interactions as well as on the impact of management on the different soil functions.

**Keywords:** soil function; European legislation; regional legislation; multifunctionality; soil policy

### 1. Introduction

Agricultural ecosystems provide a range of benefits that are vital to human well-being [1]. These benefits encompass provisioning ecosystem services, such as food, wood, fiber, fuel, and drinking water, but also regulating and cultural services such as carbon storage and aesthetics [2,3]. In turn, a range of ecosystem services and functions affect agricultural productivity [4]. This is

Table 1. Overview of 35 policy documents, which were analyzed for effects on soil functions. For each of the documents the general title, document type, and official number are given. For each document their impact, direct (dark gray) or indirect (light gray), on each of the five soil functions is given. If a direct impact is considered relevant, then the article numbers are given. In some cases almost the entire document has an impact on a function. In that case not all the article numbers are given, but a reference “Directive” or “Strategy” is given in the table.							
Agricultural Policies	Type	No.	Production of Food, Fiber and Biofuel	Water Purification and Regulation	Carbon Sequestration	Habitat for Biodiversity	Recycling of (External) Nutrients/Agro-Chemicals
European Agricultural Fund for Rural Development	Regulation	1305/2013	Directive		Article 5, 34	Article 5	
Financing Management and monitoring	Regulation	1306/2013	Directive	Article 93, 94; Annex II	Article 93, 94; Annex II	Article 93, 94; Annex II	
Direct Payment	Regulation	1307/2013	Directive	Article 44, 45	Article 44, 45	Article 44, 45	
Common organization of the markets	Regulation	1308/2013	Directive	-	-	-	
Plant Protection Products	Directive	91/414/EEC	Article 4(b)	Article 4(b)		Article 4(b)	Article 4(b)
Nitrates Directive	Directive	1991/676/EEC	Article 2				Article 2
GMOD Directive	Directive	2001/18/EC	Directive	Article 2–Annex II	Article 2–Annex III	Article 2–Annex II	Article 2–Annex II
Pesticide Use Directive	Directive	2000/128/EC	-	-	-	-	Article 12
Industrial policies							
Industrial Emissions Directive	Directive	2010/75/EU	-		-	-	Article II
Landfill Directive	Directive	1999/31/EC		-	-	-	
Mineral Waste Directive	Directive	2006/21/EC		-	-	-	
Industrial Policies	Type	No.	Production of Food, Fiber and Biofuel	Water Purification and Regulation	Carbon Sequestration	Habitat for Biodiversity	Recycling of (External) Nutrients/Agro-Chemicals
Biocidal Products Regulation	Regulation	526/2012		Article 19		Article 19	Article 19
Waste Directive	Directive	2008/98/EC	ANNEX II				
Urban policies							
Sewage Sludge Directive	Directive	96/27/EC	Article 6, 7				Article 8
Urban Waste Water Directive	Directive	91/271/EEC	Directive	-	-	-	-
Climate policies							
Carbon Storage Directive	Directive	2009/31/EC	-	-	-	-	-
Renewable Energy Directive	Directive	2009/28/EC	Article 17				
Mining and mineral raw materials	Regulation	529/2013/EU		-	Article 7		-
Monitoring and reporting	Communication	COM(2016)479	-	-	-	-	-
2030 Climate and Energy framework	Communication	COM(2014)15			Section 2.4	-	-

35 different overarching-legislative-financial/research policy areas recognised as important for their potential impact on soil functions in agricultural areas:

- 22 Directives and 8 Regulations
- 4 Communications and 1 Decision

<http://landmark2020.eu/publication-tree/publication-tree-n-4-the-impact-of-policy-instruments-on-soil-multifunctionality-in-the-european-union/>

Introduction

Knowledge

Regional

European

Discussion

LANDMARK

Introduction | Knowledge | **Regional** | European | Discussion

10

[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

www.inspiration-agenda.eu

18/04/2018

230

# STAKEHOLDER ENGAGEMENT: HARVESTING EXISTING KNOWLEDGE, REQUIREMENTS AND PRIORITIZATION OF SOIL QUALITY AND SOIL FUNCTIONS



Introduction

Knowledge

Regional

European

Discussion

11

[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018



LANDMARK



## WHICH IS THE KNOWLEDGE OF #SOIL ACROSS DIFFERENT STAKEHOLDERS?



↳ # SOIL



↳ # SOIL QUALITY and FUNCTIONS

↳ # Land and soil management practices

↳ # Actions, policies, tools, ideas, needs, requirements & concerns



## STAKEHOLDER CONSULTATION

Introduction

Knowledge

Regional

European

Discussion

LANDMARK

[www.landmark2020.eu](http://www.landmark2020.eu)

email [info.landmark@wur.nl](mailto:info.landmark@wur.nl)

twitter @Landmark2020

18/04/2018



12

[www.inspiration-agenda.eu](http://www.inspiration-agenda.eu)

# STAKEHOLDER CONSULTATION

CHALLENGE no existing method available, so we had to develop our own methodology for the stakeholder workshops.



## .. BUT BEFORE WE LEARNT FROM YOU



Dictor Marie  
@DictorMc

Following

Landmark-inspiration meeting Orleans



### INSPIRATION attended:

- ✓ Farmers Maves, France
- ✓ Regional Multistakeholders AGES, Austria
- ✓ National multistakeholders workshop APCA Paris
- ✓ EU multistakeholder workshop, Bruxelles, Belgium

21<sup>st</sup> April 2016 – Chambre d' Agriculture Region Centre, Orleans, France

Introduction

Knowledge

Regional

European

Discussion

LANDMARK

[www.landmark2020.eu](http://www.landmark2020.eu)

14

email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

[www.inspiration-agenda.eu](http://www.inspiration-agenda.eu)



18/04/2018

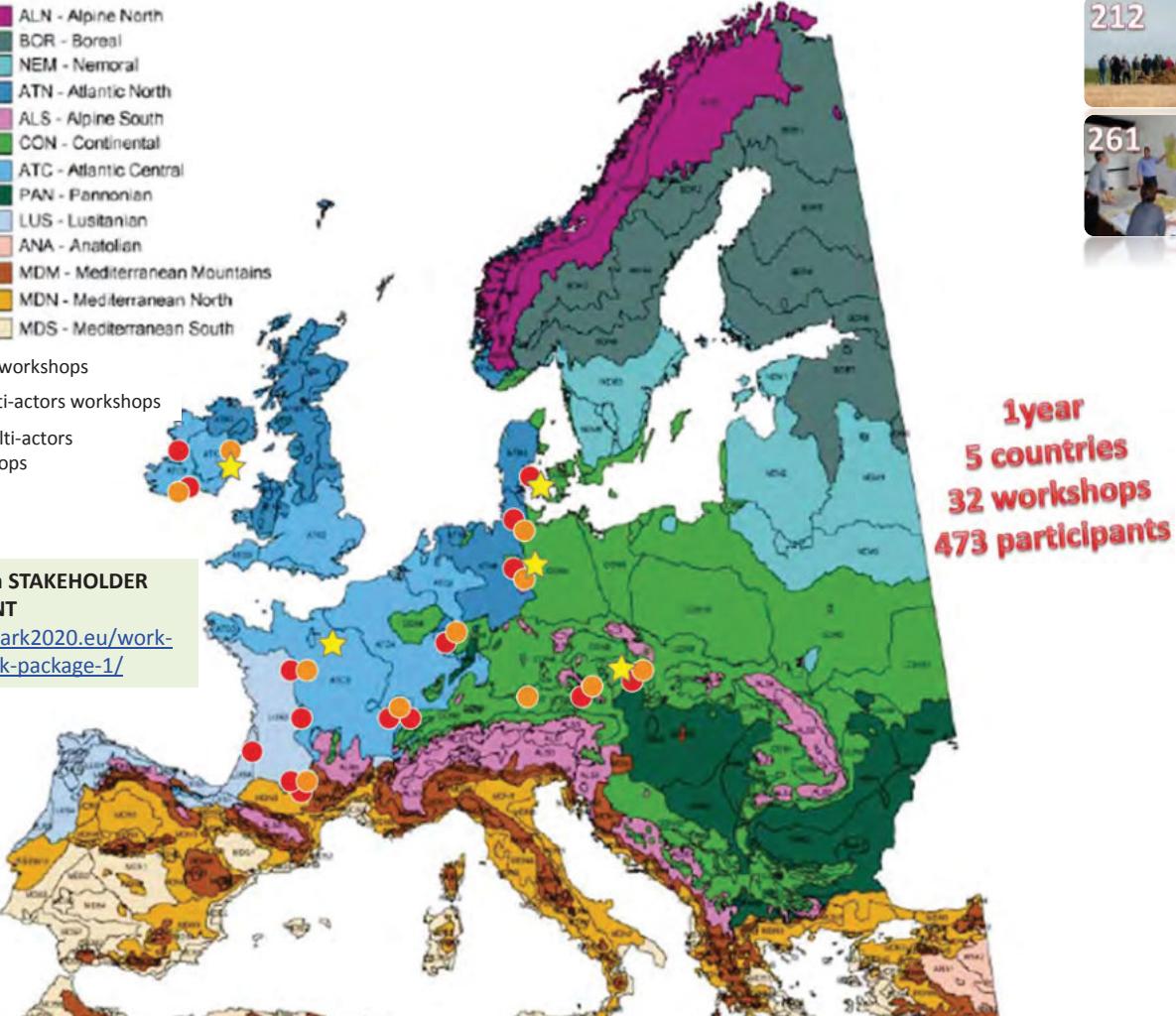
232

### Environmental Zone

- ALN - Alpine North
- BOR - Boreal
- NEM - Nemoral
- ATN - Atlantic North
- ALS - Alpine South
- CON - Continental
- ATC - Atlantic Central
- PAN - Pannonian
- LUS - Lusitanian
- ANA - Anatolian
- MDM - Mediterranean Mountains
- MDN - Mediterranean North
- MDS - Mediterranean South

- Farmers workshops
- Reg. multi-actors workshops
- ★ Nat. multi-actors workshops

More info on STAKEHOLDER ENGAGEMENT  
<http://landmark2020.eu/work-package/work-package-1/>



JEROEN VAN LEEUWEN



## DESIGNING, TESTING AND EVALUATING A MONITORING SCHEMA FOR SOIL FUNCTIONS



Introduction

Knowledge

Regional

European

Discussion

# MONITORING SOIL FUNCTIONS

- Evaluation:
  - Why is monitoring important?
  - What is needed?
  - What is currently monitored?
- Looking forward:
  - Designing and testing a monitoring schema



LANDMARK

17 [www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018 

IOP Publishing *Environ. Res. Lett.* 12 (2017) 124007 <https://doi.org/10.1088/1748-9326/aa9c5c>

## Environmental Research Letters



LETTER

OPEN ACCESS

### Gap assessment in current soil monitoring networks across Europe for measuring soil functions

RECEIVED  
27 August 2017

REVISED  
7 November 2017

ACCEPTED FOR PUBLICATION  
22 November 2017

PUBLISHED  
12 December 2017

Original content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence.

Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

J P van Leeuwen<sup>1</sup>, N P A Saby<sup>2</sup>, A Jones<sup>3</sup>, G Louwagie<sup>4</sup>, E Micheli<sup>5</sup>, M Rutgers<sup>6</sup>, R P O Schulte<sup>7</sup>, H Spiegel<sup>8</sup>, G Toth<sup>9</sup> and R E Creamer<sup>10,11</sup> 

<sup>1</sup> Biometris, Wageningen University and Research (WUR), PO Box 16, 6700 AA, Wageningen, The Netherlands

<sup>2</sup> INRA Infosol, US 1106, Orléans, France

<sup>3</sup> European Commission, Joint Research Centre, Sustainable Resources Directorate, Land Resources Unit, Via E. Fermi 2749, 21027 Ispra, Italy

<sup>4</sup> EU Delegation to Eritrea, European Commission DG International Cooperation and Development, Rue de la Loi 41, B-1049 Brussels, Belgium

<sup>5</sup> Institute of Environmental Sciences, Szent Istvan University, Páter Károly u. 1., H-2100 Gödöllő, Hungary

<sup>6</sup> National Institute for Public Health and the Environment, Antonie van Leeuwenhoeklaan 9, 3721 MA, Bilthoven, The Netherlands

<sup>7</sup> Farming Systems Ecology, Wageningen University and Research (WUR), PO Box 430, 6700 AK, Wageningen, The Netherlands

<sup>8</sup> Department for Soil Health and Plant Nutrition, Austrian Agency for Health and Food Safety-AGES, Spargelfeldstraße 19, A-1220 Wien, Austria

<sup>9</sup> Georigonik Faculty, University of Pannonia, Deák Ferenc u. 16, H-8361 Keszthely, Hungary

<sup>10</sup> Soil Biology and Biological Soil Quality, Wageningen University and Research (WUR), PO Box 16, 6700 AA, Wageningen, The Netherlands

<sup>11</sup> Author to whom any correspondence should be addressed.

E-mail: [rachel.creamer@wur.nl](mailto:rachel.creamer@wur.nl)

Keywords: soil functions, soil monitoring networks, soil attributes, Europe

Supplementary material for this article is available [online](#)

More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>



LANDMARK

[www.landmark2020.eu](http://www.landmark2020.eu)

email [info.landmark@wur.nl](mailto:info.landmark@wur.nl)

twitter @Landmark2020

18/04/2018



# WHY MONITORING?

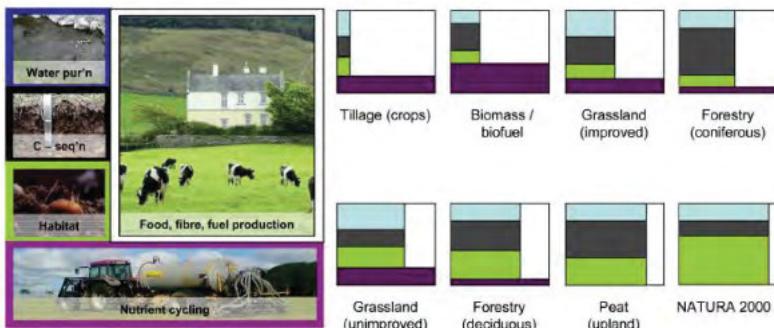


Fig. 1 – Freestyle illustration of typical suites of soil functions under contrasting land use types.

To understand the potential of our soils to deliver soil functions and enable the formation of evidence-based policies to incentivize sustainable soil management, changes in provisioning of soil functions need to be monitored

Schulte et al 2014 ESP 38:45-58



19  
[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018



# WHAT TO MEASURE?

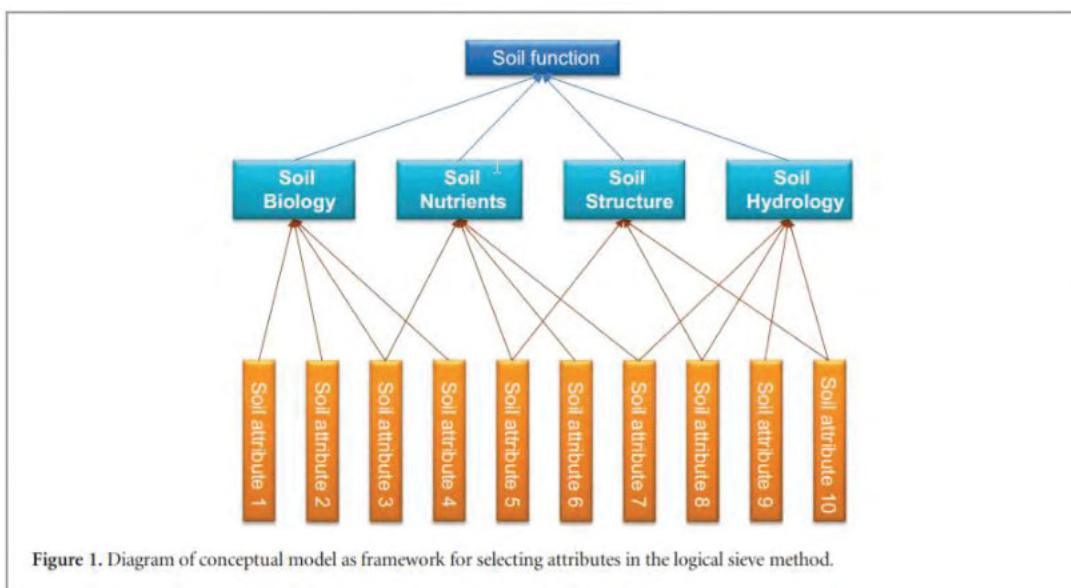


Figure 1. Diagram of conceptual model as framework for selecting attributes in the logical sieve method.

Van Leeuwen, et al. (2017), **Gap assessment in current soil monitoring networks across Europe for measuring soil functions**. Environmental Research Letters, 1748-9326.

More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>



20  
[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

[www.inspiration-agenda.eu](http://www.inspiration-agenda.eu)



235

# WHAT TO MEASURE?

**Table 1.** Top 30 of soil attributes resulting from the logical sieve. Presented are the scores from the logical sieve per soil function, and the final scores on which the attributes were ranked. In bold the three highest scores per soil function.

Attribute/SF	Primary productivity	Water regulation	C sequestration	Biodiversity	Nutrient cycling	Final score
Organic C/N/P/K	<b>2.89</b>	<b>3.47</b>	<b>2.88</b>	3.24	<b>3.42</b>	64.2
pH	2.38	2.57	2.66	3.14	<b>3.31</b>	33.7
Bulk density	<b>2.62</b>	3.20	2.69	2.70	2.63	31.9
C:N ratio	2.25	2.36	2.63	2.58	<b>3.13</b>	22.5
C mineralisation rate	2.12	2.36	3.01	2.62	2.80	22.1
Texture	2.55	2.49	2.49	3.13	2.18	21.6
Rooting depth	2.00	2.57	2.47	2.97	2.72	20.5
Microbial biomass	2.31	2.47	<b>3.47</b>	<b>3.40</b>		16.8
Drainage class	2.26	<b>3.54</b>	2.74	2.50		13.7
Soil temperature	1.90	2.04	2.21	2.43	2.59	10.8
Salinity	2.07	1.97	1.94	2.19	2.52	8.74
CEC	1.72	2.08	2.12	2.18	2.37	7.87
WHC	2.37	2.09	2.45	2.22		6.76
Groundwater table	1.84	2.42	2.27		2.54	6.42
Fe/Al	1.58	1.94	2.18	1.97	2.40	6.31
Earthworm community		3.23	1.64	<b>3.49</b>		6.16
Clay mineralogy	1.92	1.73	2.62	2.73		5.95
Soil slope	1.62	2.41	2.12	2.06		4.27
Bacterial community				<b>3.46</b>		3.46
Soil moisture	<b>2.78</b>		2.42			3.37
Microarthropod community				3.21		3.21
Fungal community				3.19		3.19
Top-layer infiltration capacity					3.11	3.11
Air-filled porosity					2.99	2.99
Field capacity days					2.96	2.96
Nematode community				2.96		2.96
Wilting point days					2.85	2.85
Enchytraeid community				2.75		2.75
Soil frost days	1.76	1.55	2.01	1.98		2.70
Redox state					2.60	2.60

Van Leeuwen, et al. (2017), **Gap assessment in current soil monitoring networks across Europe for measuring soil functions**. Environmental Research Letters, 1748-9326.

More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>

21

 [www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018



# WHAT IS MEASURED WHERE?

**Table 2.** Existing soil monitoring schemes in European countries.

Country	Start year of monitoring campaign	National sampling strategy		Description of the site				Site sampling strategy		Reference
		Type*	Number of monitoring sites	Vegetation	Geology (parent material)	Slope	Exposure	Fixed depth/pedological horizon	Depth of sampling	
Austria	1986	2	10000	yes	yes	yes	yes	fixed depth	various,	composite (BORIS 2014)
Southern Belgium	2004	2	850	yes	yes	yes	yes	fixed depth	0-20 cm	composite (Colinet et al 2016)
Southern Belgium	2014	5	120	yes	yes	yes	yes	fixed depth	Various	both (Colinet 2017)
Southern Belgium	2015	1	120	yes	no	no	no	fixed depth	0-20 cm	composite NA
Bulgaria	2003	2	10	yes	yes	yes	yes	fixed depth	60-80 cm	composite (Dinev et al 2008)
Bulgaria	2005	2	397	no	yes	no	no	fixed depth	-	replicate NA (Gubler et al 2008)
Switzerland	1985*	3	112	yes	yes	yes	yes	fixed depth & horizons	various	composite (Gubler et al 2015)
Germany	1985	2	789	yes	yes	yes	yes	horizon	0-30 cm	composite (Kaufmann-Boll et al 2012)
Germany	2010*	2	3200	yes	yes	yes	yes	fixed depth	0-100 cm	composite (Kaufmann-Boll et al 2012) (Lanthaler 2008)
Germany	various	2	45	yes	yes	yes	yes	-	-	(Kaufmann-Boll et al 2012)
Germany	1961	2	500	no	no	no	no	fixed depth	0-100 cm	- (Kaufmann-Boll et al 2012)
France	2000	2	2240	yes	yes	yes	no	fixed depth	0-50 cm	composite (Arrousays et al 2002)
France	1991	5	19	yes	yes	yes	yes	horizon + fixed depth	soil profile + 0-15 cm	individual + composite (Nicolai et al 2016)
France	2000	5	8	yes	yes	yes	yes	horizon + fixed depth	soil profile + 0-15 cm	individual + composite (Stone et al 2016)
France	2010	2	13	yes	yes	yes	yes	horizon + fixed depth	soil profile + 0-15 cm	individual + composite (Péres et al 2011)
GB	2007	4	2955	yes	yes	yes	no	fixed depth	0-15 cm	individual (Emmet et al 2010)
GB	1971	4	1648	yes	no	yes	no	fixed depth	0-15 cm	individual (Wood et al 2015)
Hungary	1992	3	1236	yes	yes	yes	yes	fix depth	0-90 cm	composite (Váraljay 2009)
Iceland	2007	2	600+	yes	no	yes	yes	fixed depth	0-30 cm	? (Hellings et al 2016)
Iceland	2005	1	1000	yes	yes	yes	yes	horizon	0-30 cm	? (Snorrason 2010)
Iceland	1999	4	1106	yes	no	yes	no	fixed depth	0-10 cm	composite (Magnússon et al 2009)
Iceland	2001	4/3	158	yes	no	no	no	fixed depth	0-10 cm	composite (Elmarsdóttir 2009)
Ireland	1995	2	1310	no	no	no	no	fixed depth	0-10 cm	composite (Fay et al 2007)
Ireland	2012	2	227	yes	yes	yes	yes	horizon	>80 cm	individual (Creamer et al 2014)
Ireland	2015	2	40	yes	yes	yes	yes	horizon	>80 cm	composite (Teagasc 2017)
Ireland	2006	5	61	yes	yes	yes	no	fixed depth	0-25 cm	composite (Schmid 2015)
Italy	1986	7	14	yes	no	no	no	fixed depth	0-60 cm	replicates (Mazzoncini et al 2016)
Italy	1993	7	256	yes	no	no	no	fixed depth	0-60 cm	replicates (Sapkota et al 2012)
Italy	2001	7	175	yes	no	no	no	fixed depth	various	replicates (Mazzoncini et al 2010)
Netherlands	1993	4	~300	yes	no	no	no	fixed depth	0-10/0-20 cm	composite (Rutgers et al 2009)
Netherlands	1984-2004	1	1,387,000	no	yes	no	no	fixed depth	various	composite (Reijneveld et al 2009)
Netherlands	1984-2004	1	>280,000	no	yes	no	no	fixed depth	various	composite (Reijneveld et al 2010)
Portugal	2015	3	100	yes	no	no	no	fixed depth	0-10 cm	NA
Scotland	1978-88	2	195 (183 with soil)	yes	yes	yes	yes	horizon	>80 cm	individual (Chapman et al 2013)
Slovenia	1989-2007	2	422	yes	yes	yes	yes	fixed depth	0-30 cm	composite (Zupan et al 2008)
Sweden	1995	4	2034	yes	no	no	no	fixed	0-20, 40-60 cm	composite (Eriksson et al 2010)

Types of sampling: 1: random sampling, 2: systematic sampling, 3: judgmental sampling, 4: stratified pattern with random sampling, 5: stratified pattern with systematic sampling, 6: stratified pattern with directed sampling, 7: nested pattern with random sampling, 8: nested pattern with systematic sampling. Reports for SMNs in Belgium and Portugal not yet available.

Environ Res Lett. 12 (2017) 124007

Letters

Van Leeuwen, et al. (2017), **Gap assessment in current soil monitoring networks across Europe for measuring soil functions**. Environmental Research Letters, 1748-9326.

More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>

22

 [www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

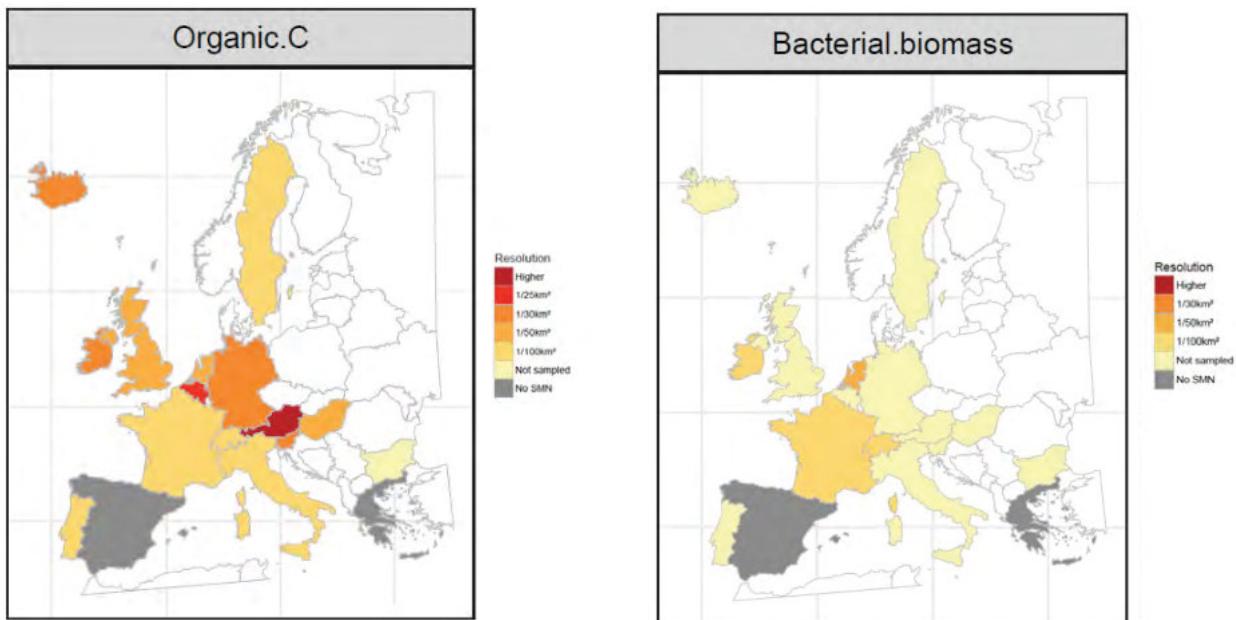
18/04/2018



www.inspiration-agenda.eu

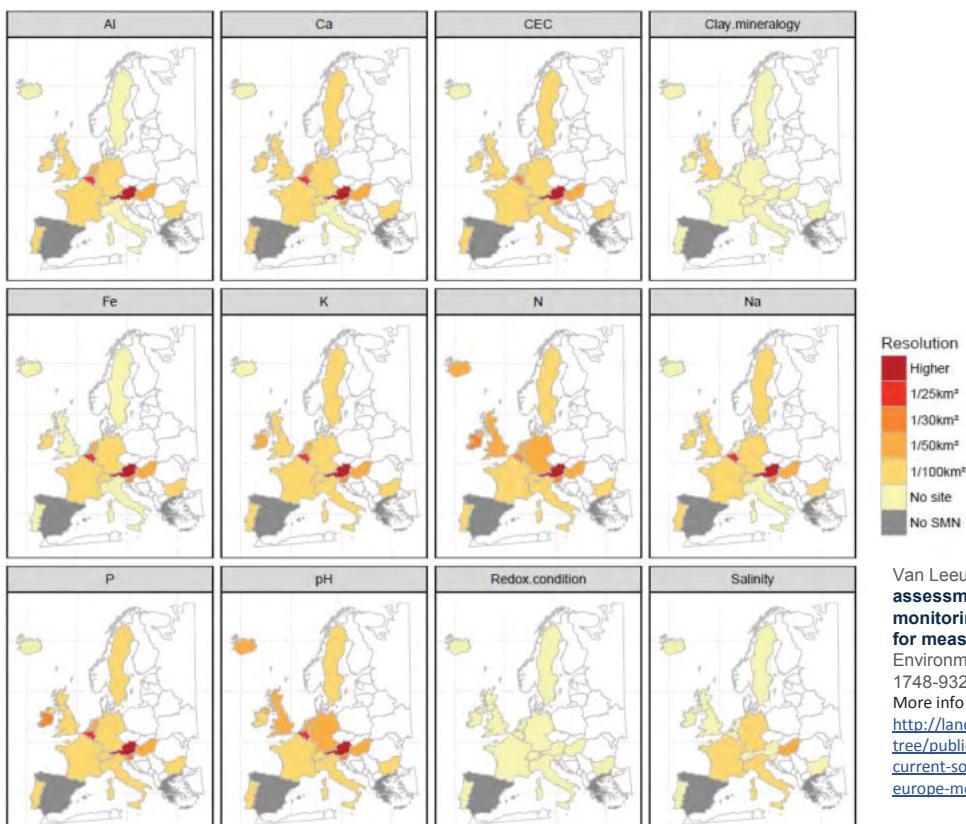
236

# WHAT IS MEASURED WHERE?



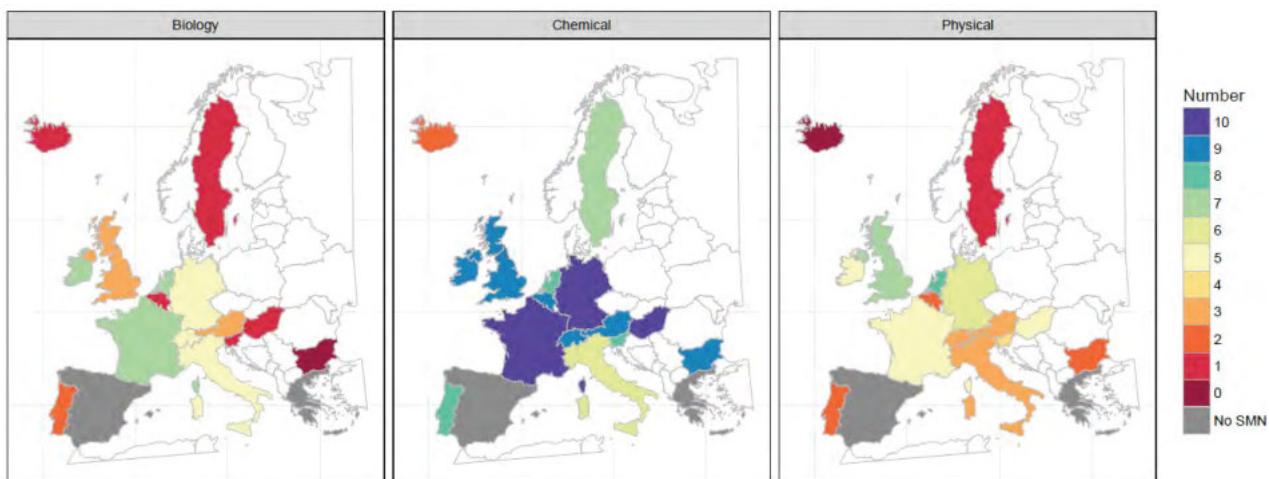
Van Leeuwen, et al. (2017), **Gap assessment in current soil monitoring networks across Europe for measuring soil functions**. Environmental Research Letters, 1748-9326.  
More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>

# WHAT IS MEASURED WHERE?



Van Leeuwen, et al. (2017), **Gap assessment in current soil monitoring networks across Europe for measuring soil functions**. Environmental Research Letters, 1748-9326.  
More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>

# WHAT IS MEASURED WHERE?



Van Leeuwen, et al. (2017), **Gap assessment in current soil monitoring networks across Europe for measuring soil functions**. Environmental Research Letters, 1748-9326.  
More info <http://landmark2020.eu/publication-tree/publication-tree-n6-gap-assessment-current-soil-monitoring-networks-across-europe-measuring-soil-functions/>



DIRK VREBOS & JAN STAES

## FUNCTIONAL LAND MANAGEMENT AT EUROPEAN LEVEL: DEMANDS ON SOIL FUNCTIONS AND SCENARIO ANALYSES



# Functional Land Management

**Aim:** Optimize the sustainable use of Europe's soil resource across all major land uses: grassland, arable and forestry.

1. Evaluate legislation in the EU and member states with regard to direct and indirect impacts on soil functions.
2. Translate policy and future trends into scenarios for demand for soil functions.
3. Optimize soil functions across the EU in light of these scenario's.



## Evaluate soil related legislation

**Vrebos D, Bampa F, Creamer R, Gardi C, Ghaley B, Jones A, et al. The Impact of Policy Instruments on Soil Multifunctionality in the European Union. Sustainability 2017; 9: 407.**

More info: <http://landmark2020.eu/publication-tree/publication-tree-n-4-the-impact-of-policy-instruments-on-soil-multifunctionality-in-the-european-union/>

A screenshot of a journal article from the Sustainability journal. The article is titled "The Impact of Policy Instruments on Soil Multifunctionality in the European Union". It is authored by Dirk Vrebos, Francesco Bampa, Rachel E. Creamer, Ciro Gardi, Bhim Bahadur Ghaley, Arwyn Jones, Michiel Rutgers, Taro Sandén, Jan Stas, and Patrick Meire. The article is categorized under "Article". The MDPI logo is visible in the top right corner. The abstract discusses the impact of various policy instruments on soil multifunctionality in the European Union, noting the complexity of interactions between different soil functions and the challenges of implementing policies that benefit multiple functions simultaneously. The article was received on 28 January 2017, accepted on 2 March 2017, and published on 9 March 2017. The keywords listed are soil function, European legislation, regional legislation, multifunctionality, soil policy. The full text of the article is available at [www.mdpi.com/2073-4412/9/3/407](http://www.mdpi.com/2073-4412/9/3/407).

## Evaluation of EU legislation

35 different documents were considered important for their potential impact on soil functions in agricultural areas:

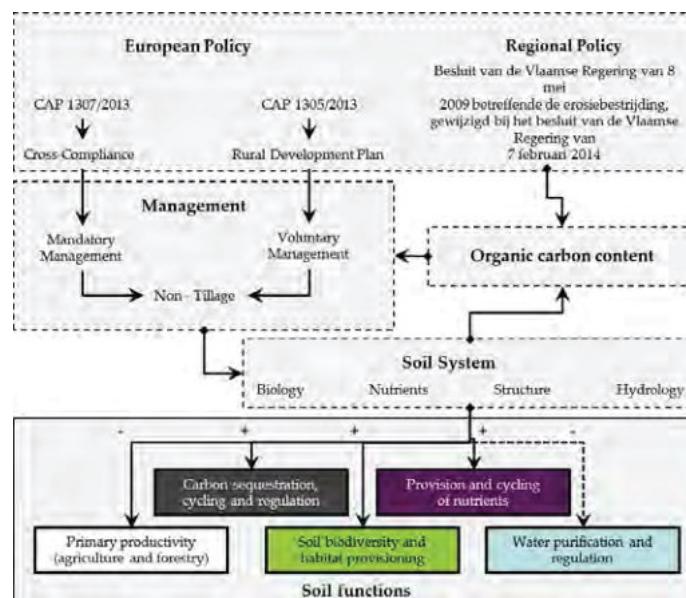
22 Directives, 8 Regulations, 4 Communications and 1 Decision.

**Table 1.** Overview of 35 policy documents, which were analyzed for effects on soil functions. For each of the documents the general title, document type, and official number are given. For each document their impact, direct (dark gray) or indirect (light gray), on each of the five soil functions is given. If a direct impact is considered relevant, then the article numbers are given. In some cases almost the entire document has an impact on a function. In that case not all the article numbers are given, but a reference "Directive" or "Strategy" is given in the table.

Agricultural Policies	Type	No.	Production of Food, Fiber and (Bio)Fuel	Water Purification and Regulation	Carbon Sequestration	Habitat for Biodiversity	Recycling of (External) Nutrients/Agro-Chemicals
European Agricultural Fund for Rural Development	Regulation	1305/2013	Directive		Article 5, 34	Article 5	
Financing Management and monitoring	Regulation	1306/2013	Directive	Article 93, 94; Annex II	Article 93, 94; Annex II	Article 93, 94; Annex II	
Direct Payment	Regulation	1307/2013	Directive	Article 44, 45	Article 44, 45	Article 44, 45	
Common organization of the markets	Regulation	1308/2013	Directive	-	-	-	
Plant Protection Products Directive	Directive	91/414/EEC	Article 4,b	Article 4,b		Article 4,b	Article 4,b
Nitrate Directive	Directive	1991/676/EEC	Article 2				Article 2
GMO Directive	Directive	2001/18/EC	Directive	Article 2-Annex II	Article 2-Annex II	Article 2-Annex II	Article 2-Annex II
Pesticide Use Directive	Directive	2009/128/EC	-	-	-	Article 12	-
Industrial policies							
Industrial Emissions Directive	Directive	2010/75/EU	-		-	-	Annex II
Landfill Directive	Directive	1999/31/EC	-	-	-	-	-
Mining Waste Directive	Directive	2006/21/EC	-	-	-	-	-
Industrial Policies	Type	No.	Production of Food, Fiber and (Bio)Fuel	Water Purification and Regulation	Carbon Sequestration	Habitat for Biodiversity	Recycling of (External) Nutrients/Agro-Chemicals
Biochemical Products Regulation	Regulation	528/2012	-	Article 19	-	Article 19	Article 19
Waste Directive	Directive	2008/98/EC	ANNEX II	-	-	-	-
Urban policies							
Sewage Sludge Directive	Directive	86/278/EEC	Article 6, 7				Article 8
Urban Waste Water Directive	Directive	91/271/EEC	Directive	-	-	-	-
Climate policies							
Carbon Storage Directive	Directive	2009/31/EC	-	-	-	-	-
Renewable Energy Directive	Directive	2009/28/EC	Article 17				
Monitoring and reporting greenhouse gas emissions	Regulation	529/2013/EU		-	Article 7		-
Monitoring and reporting greenhouse gas emissions	Communication	COM/2016/479	-	-	*	*	-
2030 climate & energy framework	Communication	COM(2014) 15	-	-	Section 2.4	-	-

## Examples of Regional legislation

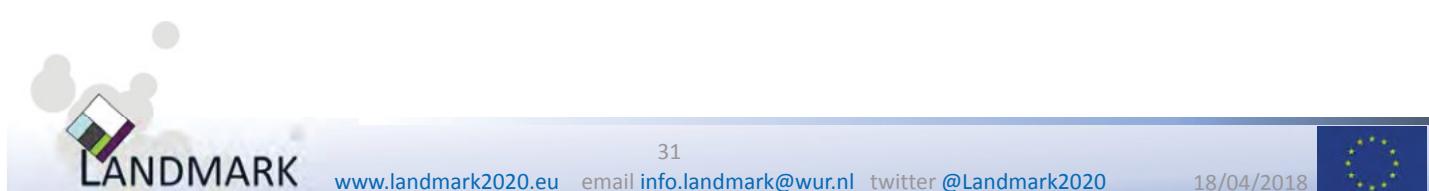
- Translation of EU policy to national/regional level differs and can interact with other region-specific legislation.
- Final outcome of EU policy on soil functions can therefore differ across the EU.



## Conclusions

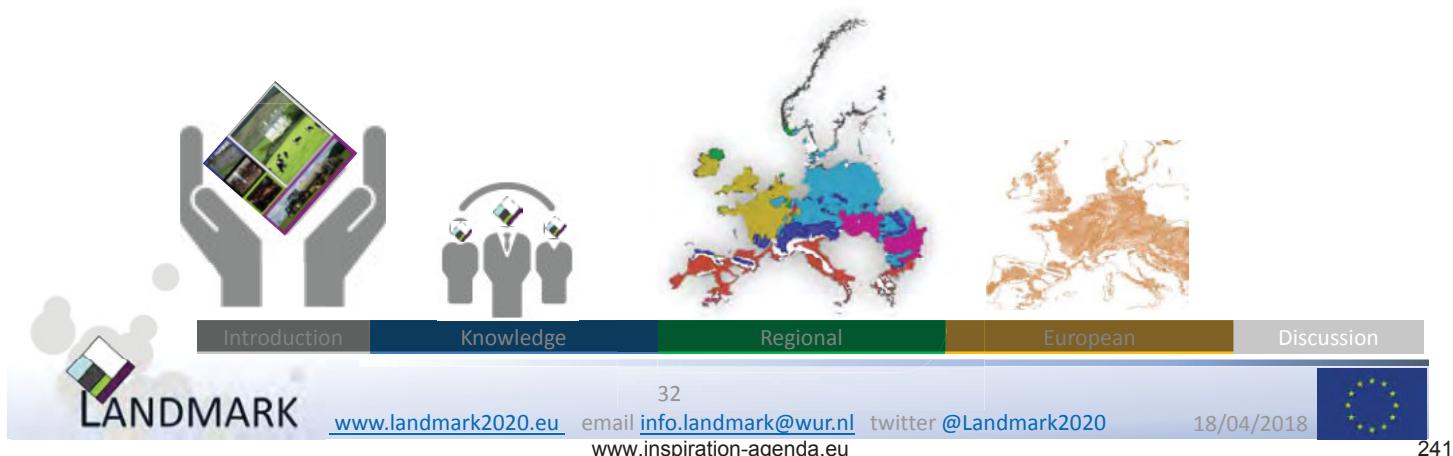
- Soil functions are impacted by different policy domains and levels of legislation.
- Some functions are directly addressed by a policy, whereas others may be indirectly addressed, depending on the policy and on the location or region where it applies.
- Policy documents do not directly deal with all soil functions. In most cases, only a few functions are affected directly or indirectly within specific designated areas.
- More research is needed on the combined effect of European and regional policies on soil functions in agricultural ecosystems to understand their fully combined effects.

More info: <http://landmark2020.eu/publication-tree/publication-tree-n-4-the-impact-of-policy-instruments-on-soil-multifunctionality-in-the-european-union/>



# LANDMARK STRATEGIC RESEARCH AGENDA

## PROJECT COORDINATOR: RACHEL CREAMER (WUR2)



# STRATEGIC RESEARCH AGENDA: APPROACH



Introduction

Knowledge

Regional

European

Discussion



33

[www.landmark2020.eu](http://www.landmark2020.eu) email [info.landmark@wur.nl](mailto:info.landmark@wur.nl) twitter @Landmark2020

18/04/2018

