iSQAPER

Interactive Soil Quality Assessment in Europe and China for Agricultural Productivity and Environmental Resilience

Periodic Report Period 1

1-5-2015 – 31-10-2016

Grant Agreement 635750

partici-pants	iSQAPER Participant legal name + acronym	Country
1 (Coor)	Wageningen University (WU)	Netherlands
2	Joint Research Center (JRC)	Italy
3	Research Institute of Organic Agriculture (FIBL)	Switzerland
4	Universität Bern (UNIBE)	Switzerland
5	University of Évora (UE)	Portugal
6	Technical University of Madrid (UPM)	Spain
7	Institute for European Environmental Policy (IEEP)	UK and Belgium
8	Foundation for Sustainable Development of the Mediterranean (MEDES)	Italy
9	ISRIC World Soil Information (ISRIC)	Netherlands
10	Stichting Dienst Landbouwkundig Onderzoek (DLO)	Netherlands
11	Institute of Agrophysics of the Polish Academy of Sciences (IA)	Poland
12	Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences (IAES)	Estonia
13	University of Ljubljana (UL)	Slovenia
14	National Research and Development Institute for Soil Science, Agrochemistry and Environmntal Protection (ICPA)	Romania
15	Agrarian School of Coimbra (ESAC)	Portugal
16	University of Miguel Hernández (UMH)	Spain
17	Agricultural University Athens (AUA)	Greece
18	Institute of Agricultural Resources and Regional Planning of Chinese Academy of Agricultural Sciences (IARRP)	China
19	Institute of Soil and Water Conservation of Chinese Academy of Sciences (ISWC)	China
20	Soil and Fertilizer Institute of the Sichuan Academy of Agricultural Sciences (SFI)	China
21	CorePage (CorePage)	Netherlands
22	BothEnds (BothEnds)	Netherlands
23	University of Pannonia (UP)	Hungary
24	Institute of Soil Science of the Chinese Academy of Sciences (ISS)	China
25	Gaec de la Branchette (GB)	France

Contents

iSQAPER First Periodic Report
Part B Report Core

1. Explanation of the work carried out by the beneficiaries and Overview of the progress

1.1 Objectives

1. *Integrate existing soil quality related information with characterisations of crop and livestock farming systems in various pedo-climatic zones across Europe and China (Deliverables WP2, end-date month 20)*

   This objective is concerned with the collection and classification of soil, climate and land use data to characterise the edaphic aspects of typical crop and livestock farming systems across Europe and China. The first step is to conceptualise the scale-dependency of different levels of pedo-climatic zones, taking into account the differences between- and inside main climate regions. This assessment is based on the evaluation of soil water and nutrient status and dynamics. Data need and availability of the conceptual model is assessed and an inventory of regional data availability status on different established. Geographical representation of cropping systems will be produced in parallel, using land use and land cover information. Analysis of the linkages between land use/cover and livestock systems will be performed. Definition, classification and spatial delineation of pedo-climatic regions as well as appraisal of their relation to crop and livestock farming systems will be delivered.

   During this reporting period an inventory was made of available pedological and climatic data in order to construct pedo-climatic zones (Milestone 2.1). The spatial extent of Reference Soil Groups represent the major units of pedo-climatic zones. The delineation of pedo-climatic zones is based on regional soil differentiation rules, both in China and Europe. Pedo-climatic zones were further subdivided by introducing second-level soil qualifiers within the pedo-climatic zones which hold information on potentials of soil water and nutrient status and dynamics. As such, a hierarchical system is established to better understand the basic situation of soil resources, and analyse the status quo and potential. Numerical approaches are applied to map the spatial extent of pedo-climatic zones in a comparable manner in China and Europe (Deliverable 2.1). Also, a review was made of different approaches to farming system classifications. For iSQAPER we define farming systems as the “representation of the combination of cropping and livestock activities and the resources available (pedo-climatic conditions) to the farmers to raise them for their production purposes”. The proposed classification of farming systems (Deliverable 2.2) groups practices based on the most important land use types including plant and animal breeding, under the highest categories of Arable land, Permanent Crops, Pastures and Livestock systems.

2. *Synthesize the evidence for agricultural management effects provided by long-term field trials across Europe and China on soil physical, chemical and biological properties, including interactions, and related ecosystem services such as agricultural productivity and yield stability (Deliverables WP3, end-date month 29)*

iSQAPER aims to mine the existing data on soil quality as assessed in European and Chinese field trials to identify the best subset of measurements that could be used to develop (aggregate) indicators of agricultural soil quality for desired ecosystem services. Data from published literature, as well as raw data from ongoing field trials and the identification of knowledge gaps in the field of quality indicator systems will be analysed and knowledge gaps emerging during screening of (data underlying) existing indicator systems and early development of SQAPP will be identified. Where needed, additional experimental work will be carried out at long-term field sites to fill the most important knowledge gaps on how soil type, climatic zone, topography and crop and land management interact to affect soil quality parameters. The WP will include a core set of >30 existing long-term field experiments selected to represent both cropland and pasture/grassland systems on a range of soil types in the dominant European and Chinese climatic zones.

In this reporting period, the existing field trials available to iSQAPER in Europe and China were documented (Milestone 3.1) and a database of existing long-term experiment (LTE) data was compiled in Task 3.2. The effects of five management practices on six soil quality indicators was evaluated in a meta-analysis. We examined these indicators under paired management practices, i.e. organic matter addition versus no organic matter input, no-till versus conventional tillage, crop rotation versus mono-cropping, irrigation versus rainfed farming, and organic versus conventional agriculture. We analysed trends of the indicators and their relative changes under the paired practices based on the collected LTE data. In addition, we collected over 900 peer-reviewed papers and reports using various web-based search engines, and entered the evidence presented in the literature (some 400 references) into a literature review database (LR-database). We calculated a ratio for each indicator for a given paired-practice, for example, soil organic carbon (SOC) content under no-till divided by SOC content under conventional tillage for each LTE. The results showed that earthworms and soil organic carbon/matter were the most sensitive indicators for the examined practice combinations. Water holding capacity, aggregate stability and yield were less sensitive and pH was the least sensitive indicator. The lack of a coherent dataset from all LTEs was identified as an important knowledge gap that was addressed in a sampling campaign performed in Task 3.3. The evaluation of this dataset will allow assessing how environmental conditions and land management affect soil quality indicators, and to identify the most cost-effective minimum dataset of soil quality indicators.

3. *Derive and identify innovative soil quality indicators that can be integrated into an easy-to-use interactive soil quality assessment tool, accounting for the effects of agricultural land management practices and related effects upon ecosystem services (Deliverables WPs 3 and 4, end-date month 24)*

   Soil physical, chemical and biological measurements are proposed in a series of soil quality and soil health concepts all over the world. An overview of such soil quality concepts was produced in 2009 in Switzerland by Agroscope and FiBL. In iSQAPER, we update this compilation and evaluate the different soil quality indicators with respect to sensitivity to indicate soil threats, soil functions and land potential as well as reliability, simplicity and cost-effectiveness. The outcome of this review is a set of parameters which will be used to assess soil quality in various pedo-climatic conditions in Europe and China. The field of soil quality indicators is rapidly developing and there is a need to improve the capacity and methods for assessing soil-management interactions and their impact on soil functions. Newly developed state-of-the-art soil biological, chemical and physical methods will be evaluated using soils from the long-term field trials. The focus will be on enhancing biological soil quality assessment in the search for cost-effective indicators that respond more quickly and predictably to environmental and management stress as well as to soil remediation measures

A critical review of existing concepts of soil quality (Task 3.1) started by clarifying the important terminology and establishing linkages between soil functions, ecosystem services and soil threats, thus laying the conceptual basis for the objective. The basis was elaborated in a workshop that took place in Frick, Switzerland, in October 2015. A meta-analysis/literature review was made in which 49 soil quality concepts from around the world were reviewed critically, from their objectives and target users to the proposed indicators and evaluation. The following indicators were most frequently used: bulk density, particle-size distribution (texture), plant-available water and aggregate stability among the soil physical properties, total organic carbon, pH, available P and total nitrogen among the soil chemical properties, and soil respiration, nitrogen mineralisation, microbial biomass and earthworms among the soil biological properties. The review of soil quality concepts yielded important conclusions towards the cornerstones of a new soil quality concept. As a first step, the objectives need to be clearly stated and target users named and involved in the process. Subsequently, indicators with clear linkages to targeted soil functions and ecosystem services should be selected. Here, flexibility with respect to used indicators, including substitute indicators or parallel lines of evidence, and considering soil indicators as well as non-soil indicators, would be an asset. Arguably, the most important part of a soil quality concept is then to establish a sound interpretation of each indicator as well as an aggregated overall rating of soil quality. Based on the previous steps, an interactive tool can be created that ideally will include management advice. The review and new soil quality framework are reported in Deliverable D3.1 (month 20, November 2016).

4. *Develop, with input from a variety of stakeholders, a multilingual Soil Quality Application (SQAPP) for in-field soil quality assessment and monitoring as an example of social innovation that allows interaction between multilevel actors (Deliverables WP4, first release SQAPP month 24, final version month 58)*

The development of a soil quality assessment tool is the central focus of the project. The tool will be developed in the format of an IT app – Soil Quality app (SQAPP) – running on mobile and/or notepad devices to facilitate in-field data collection. The app will be designed such that it can either be used stand-alone or allow connection with a server in the cloud where an extensive database will inform the SQAPP user immediately about the state of soil quality and recommended measures for improvement (these recommendations will follow from analysis in WP6). The app will accommodate operation at different levels of complexity, starting off with a minimum data set of easily observable/measurable indicators (WP3) which can be extended when more detailed data are available. At the same time, data submitted to the server can be used to inform aggregate soil quality monitoring. However, the user will be in control regarding data sharing. Some web-based functionality may only be available to users sharing data, e.g. regional reference values may depend on user contributions and as such could be regarded as premium content for those who do. WP4 internalises all activities directly geared towards development of the app, while strong linkages to other WPs will ensure iterative improvements to the app.

Progress so far has been on engaging with farmers, software developers and researchers to lay out the conceptual foundations of the SQAPP (as part of Task 4.1). Multiple sessions were organised to interact with different audiences and discuss or receive feedback on conceptual ideas. In the next reporting period, work will continue with formalising the specifications of

SQAPP design and functionality at different levels of complexity, and develop a first release of SQAPP (Task 4.2). Intensive multi-actor multi-level testing of the SQAPP follows in WP5 and 6, after which an analysis is made of first release performance and an upgrade of SQAPP will follow. Later, similar feedback procedures will result in a beta-release and final SQAPP version.

5. *Test, refine, and roll out SQAPP across Europe and China as a new standard for holistic assessment of agricultural soil quality (Deliverables WPs 4, 5 and 6, end-date month 58)*

   In the current reporting period, this objective was not yet addressed. It is planned to be a core objective in the next stage of the project, and will be reported on starting from the second periodic report.

6. *Use a trans-disciplinary, multi-actor approach to validate and support SQAPP and to become truly relevant for agricultural practice under a wide range of circumstances (Deliverables WPs 5 and 6, end-date month 48)*

   For all 14 case study sites in Europe and China the stakeholder inventory was conducted using a snowball sampling approach adapted to the project situation from a similar method applied in the EU-RECARE project (Leventon et al 2016). In this approach, a first set of stakeholders known to the case study partners fill in a questionnaire and identify several other stakeholders each. This “secondary” set of stakeholders is interviewed and, in turn, each interviewee identifies further stakeholders. This loop is repeated until the overlap between already interviewed stakeholders and new suggestions increases significantly, or until the case study partner considers the variety of stakeholders as sufficient. Milestone M5.1 is the compilation of the stakeholder inventory. This milestone shows per Case Study Site, 14 in total, the numbers and types of stakeholders approached by the research teams of iSQAPER. Their number varies from 2 to 53, in total 234 stakeholders for iSQAPER were identified. Many of the Chinese stakeholders are from agricultural institutes or villages that work with cooperatives representing more than 50 persons per stakeholder. That multiplies the number of stakeholders that are (in)directly related to iSQAPER.

   A total of 155 plots/farms were identified, 115 in Europe and 40 in China, covering 9 Climatic regions and the most common soil types within each region. Innovative and promising agricultural management practices (AMPs) were identified in a transdisciplinary approach. The most identified innovative AMPs in Europe were: Manuring & Composting, Min-till and Crop rotation. In China the most identified AMPs were: Manuring & Composting, Residue maintenance/Mulching and No-till. Using the most important soil threats in every Case Study Site area and the relevance of AMP towards the different soil threats, 23 testing sites were preliminarily selected. Testing sites are spread across all Case Study site areas and account for 14 different innovative AMPs (or combinations). This activity resulted in Milestone 6.1. This task is ongoing in the following years in order to test innovative AMPs in a transdisciplinary approach to support and validate SQAPP.

7. *Develop scenarios of how widespread application of improved agricultural management practices can contribute to a lower soil environmental footprint at a continental scale (Europe and China), while maintaining or increasing crop productivity and yield stability (Deliverables WP7, end-date month 54)*

In the current reporting period, this objective was not yet addressed. It is planned to be a core objective in the third stage of the project, and will be reported on starting from the second periodic report.

8. *Carry out an integrated assessment of existing soil and agriculture related EU and national (including China) policies and derive recommendations for improvement, i.e. through the post-2020 CAP (Deliverables WP8, end-date month 60)*

   A stocktaking survey of existing policies in the EU and China will establish in how far policy measures could be informed and enhanced by the results of earlier WPs and the scope for initiating innovative approaches in future. Problems identified in designing, implementing and monitoring policy measures at different scales will be documented and key cross-cutting issues identified. It can be difficult to specify those management practices required to meet soil quality objectives in a way which is both precise and relevant to variations in soil, cropping patterns, climate and weather conditions, etc. The project will generate both data and accessible, cost efficient tools (i.e. SQAPP) which farmers will be able to utilize in order to monitor and respond to changes in the critical parameters of the soil on their holdings. These insights and outputs can be applied to policy at different levels, from the broader European scale/level down to the individual farm. Lessons will be drawn from the different WPs to help design policies which introduce obligations on farmers, such as the GAEC component of cross-compliance, and those which involve voluntary agreements, such as agri-environment schemes. Soil monitoring tools have the potential to allow a more proactive role for farmers in meeting defined objectives and will assist the capacity of public administrations to evaluate the efficacy of different management practices. Policy measures then can be better calibrated to the most effective forms of management and progress made towards a predominantly results-based approach in agri-environment policy. The analysis will support wider policy conclusions relevant to measures in the current programming period and to the design of the next set of CAP reforms to be completed by 2020.

   In this reporting period, work has started with scoping meetings to define a short list of concepts and priorities upon which to focus policy analysis. Building on this and to validate the core teams prioritisation a short questionnaire was completed by each partner/attendee at the plenary session in Hungary in June 2016 to allow the team to understand the perceptions of soil protection, policy and policy making across the iSQAPER case studies. The core effort completed so far (under Task 8.1) has focused on a systemic review of policies at EU level and national level (and in some cases regional level) in Europe that impact on the protection of soils on agricultural land. Attention was also given to the international agenda and context and policy actions in place in China. Two questionnaires were developed in June/July 2016 to provide an initial exploration of policy issues and factors of importance. The international agenda and in particular the Sustainable Development Goals and developments under the UNFCCD on the concept of Land Degradation Neutrality (LDN) offer a potential opportunity for iSQAPER both to feed in expertise and for the promotion of interest and monitoring of soils – relevant to the app development. Training sessions on the CAP and LDN were organised for project partners and topics for a series of five policy briefs each up to 10/15 pages in length were identified.

9. *Disseminate project results using a variety of formats and media to inform and engage targeted stakeholders, ranging from land users to high-level policy makers and the general public (Deliverables WP9, end-date month 60).*

This objective, addressed in a dedicated work package (WP9) focuses on disseminating project outputs and relative information which can enhance the impact of the project to professional and public individuals. This involves coordinating and facilitating contact and communication with the different groups of actors and target audiences who will be involved in iSQAPER, potential users of SQAPP and the wider public, and ensuring efficient and effective dissemination of knowledge generated in the project using a variety of media and methods as appropriate for the different actors and target audiences. To achieve this objective, an iSQAPER Dissemination and Communication Strategy will be formulated, methods of knowledge transfer and dissemination will be developed, an iSQAPER information system set up, the SQAPP will be promoted, and visual project impact created.

During this period, progress has focused on two of the five tasks. The first version of the Dissemination and Communication strategy (Task 9.1, Deliverable 9.2) has been written with key messages from each study site and WP provisionally identified for different target audiences (or stakeholder groups). The title of Deliverable 9.2 changed from “Dissemination and Communication Strategy” to “Plan for the Exploitation and Dissemination of Results (PEDR)” reflecting latest Horizon2020 guidance, and expanding its contents to include attention to Open Access to Publications and Research Data and the Data Management Plan. The iSQAPERiS website (www.iSQAPER-is.eu) has been set up with most of the necessary functionality and a provisional structure designed to enhance the communication of the research results (Task 9.3). The other three tasks have not been active in this period although discussions have been held about a partner training event in the next period (Task 9.2) and initial ideas have been developed for the film (Task 9.5).

1.2 Explanation of the work carried per WP

1.2.1 Work Package 1

Summary

WP1 has links to all WPs and partners, as it manages the whole project and coordinates data management strategies. There are in particular links with WP9 as communication, dissemination and visibility of the project are closely linked.

The **overall objective** of WP1 is two-fold: 1) to ensure proper activity management of the project; and 2) to streamline any administrative, financial, legal and IP (Intellectual Property) issues in order to enable RTD partners to focus on their research activities.

Specific **sub-objectives** are:

1. Activity management to facilitate smooth operation of the project objectives by supporting the coordinator, WP leaders and other partners, and compiling the periodic activity reports (Task 1.1);
2. To handle all the financial, administrative and legal matters of the consortium (Task 1.2);
3. Address gender equality issues in the project (Task 1.3);
1. To ensure good communication within the project, and to parties outside the consortium, including the management of data (Task 1.4);
4. To organize plenary project meetings and to facilitate the organization of Scientific Board meetings (Task 1.5).

Details for each task

Within the first periodic reporting phase (months 1-18), the following achievements have been made (progress included in italics):

Task 1.1: Activity management to facilitate smooth operation of the project objectives by supporting the coordinator, WP leaders and other partners, and compiling the periodic activity reports (Lead partner: WU)

Within task 1.1, the following activities have received the required attention and successful follow-up:

- Activity management aiming at i) maintenance of the project work plan and monitoring of its implementation (*done on a daily basis*), ii) identification of required corrective actions and contingency plans (*no need for action in this period*), iii) implementation of decisions of the project managerial bodies (*done accordingly*)
- Coordination of reporting procedures aimed at preparing periodic and final activity reports that comply with the EC rules (*done, resulting in the 1st periodic progress report of the iSQAPER project*)
- Give overall direction to the project and provide follow-up on decisions of the plenary project meetings and the Scientific Board meetings (*done on a continuous basis to ensure proper execution of the project*)
- The Project Advisory Board will be recruited and consulted regularly (*done on an ad-hoc basis so far, with invitation to plenary project meetings and/or targeted WP leader intermediate meetings*)

Task 1.2: Financial and legal management (Lead partner: WU)

Activities within task 1.2 resulted in the following achievements:

- Financial administration with the aim of i) timely distribution of funding to the partners via a dedicated Euro account (*done)*, ii) budget management, utilization and monitoring (*performed on a weekly basis*), and iii) preparation of periodic consortium consolidated financial statements (*done for periodic reporting phase 1-18 months*)
- Coordination of reporting procedures is aimed at preparing periodic and final management reports that comply with the EC rules, including justification of costs and Form C of all beneficiaries (*done for periodic reporting phase 1-18 months*)

Task 1.3: Gender equality (Lead partner: CorePage)

Task 1.3 is meant to actively promote gender equality within the iSQAPER consortium, and will also pay due attention to gender related aspects in executing the project, especially in relation to activities in each of the Case Study Sites. Analyses will result in gendered Case Study Site mappings. Questionnaires and reports required by the European Commission concerning gender issues will be submitted. (*The activities deployed within the period 1-18 months have resulted in a dedicated gender equality report, iSQAPER report no. 5*)

Task 1.4: Communication and data management (Lead partners: WU and MEDES)

Task 1.4 consists of the following actions:

- To establish and maintain a project website and co-define the functionality of the iSQAPER Information System (iSQAPERiS) in collaboration with WP9 (*project websites designed,* *constructed, filled, and maintained, see, for more information: www.iSQAPER-project.eu and www.iSQAPER-is.eu*)

- To prepare a project dissemination, communication and visibility plan in collaboration with WP9 (*achieved, and delivered as iSQAPER report no. 6 (Deliverable 9.2))*
- To initiate and develop project working papers and project communication series for, respectively, internal and external communication of project results; also in collaboration with WP9 *(respective series have been launched and all project reports are allocated report numbers accordingly)*
- To produce a data management plan *(version 1 of the iSQAPER data management plan released as iSQAPER report no. 8 (Deliverable 1.2))*

Task 1.5: Organisation of meetings (Lead partner: WU and others)

In order to ensure appropriate progress of the iSQAPER project and outlining activities for future execution according to the Description of Action, the following issues deserve required attention:

- Smooth organization and facilitation of activities of the project will be achieved by plenary meetings planned well in advance, which ideally will be hosted by partner organisations with Case Study Sites in Europe and China representing different pedo-climatic zones. The goal of the meetings is to evaluate project progress, to outline work plans, to have scientific discussions, targeted training sessions for project partners, and to receive updates regarding the financial and IP status and interactions with the EC (*within period 1-18 months a successful plenary kick-off meeting has been organised in Vitre, France, followed by multiple bilateral staff exchanges between different participating partner institutions. A second plenary meeting was organised in Balatongyörök, Hungary*)
- Organisation and facilitation of Scientific Board meetings, which will be either physical meetings or electronic meetings, whatever is most appropriate at the time. Partner 1 (WU) will facilitate the organization of Scientific Board meetings which will be planned ahead of time (*A range of other project related meetings have been organised during the first 18 months of the project, among which i) weekly project coordination team meetings at Wageningen University, ii) monthly electronic meetings with all Chinese participants, especially to ensure access to required project funds through MOST, iii) regular electronic meetings with all Case Study coordinators, iv) regular electronic meetings with the Work Package leaders, and v) ad-hoc meetings between different project institutions, staff members, administrative/financial units, and students*)

1.2.2 Work Package 2

Summary

This WP is dedicated to the collection and classification of soil, climate and land use data to characterise the edaphic aspects of typical crop and livestock farming systems across Europe and China. The first step is to conceptualise the scale-dependency of different levels of pedo-climatic zones, taking into account the differences between- and inside main climate regions. This assessment is based on the evaluation of soil water and nutrient status and dynamics. Data need and availability of the conceptual model is assessed and an inventory of regional data availability status on different established. Geographical representation of cropping systems will be produced in parallel, using land use and land cover information. Analysis of the linkages between land use/cover and livestock systems will be performed. Definition, classification and spatial delineation of pedo-climatic regions as well as appraisal of their relation to crop and livestock farming systems will be delivered.

This WP contributes to WP3 by identifying distinct combinations of farming systems and pedo-climatic situations for detailed studies; to WP4 by demonstrating data availability for different regions/scales and providing geo-referenced data for the implementation of the Soil Quality app; and to WP7 by contributing data for scenario studies.

The main objectives of WP2 are to:
1. To collect and classify soil, climate and land use data (Task 2.1);
2. To create harmonised spatial layers of soil, climate and land use/cover data (Task 2.2);
3. To establish pedo-climatic zones by integrated analyses of soil water and nutrient regimes and climatic factors (Task 2.3);
4. To classify farming systems across Europe and China (Task 2.4);
5. To analyse farming systems in the pedo-climatic zones (Task 2.5).

Details for each Task

Task 2.1: Collection and classification of soil, climate and land use data (Lead partner: UP, partners: JRC, ISRIC, ISS, IARRP)

Task description

Pan-European climate, land use and all soil data will be collected according to the requirements of the data-user WPs, and in accordance with the Data Management Plan (WP1). Similar data from China will also be listed. Data will then be classified according to their spatial and semantic coverage in relation to existing soil quality indicators (link to WP3) and the input need of the Soil Quality Assessment Tool (link to WP4).

Task 2.2: Creation of harmonised spatial layers of soil, climate and land use/cover data (Lead partner: JRC, partners: ISRIC, UP, ISS)

Task description

Due to diverse spatial and temporal scale of potential input data, as well differences in semantic content and quality of information a harmonisation of data layers need to be performed. This work includes harmonization of geographic components (e.g. formats and resolution) and biophysical data content (e.g. soil property information) of geodatabases. Special attention will be given to primary (measured) and secondary (modelled) data. INSPIRE (Infrastructure for Spatial Information in Europe) compliancy will be secured and structured metadata catalogue will be created to accompany the harmonised database for use in the following WPs.

Activities and results

Task 2.1 and 2.2 concern an inventory of available soil, land use and purpose specific climate data and regional representation of soil and land use data available on a GIS platform. The database developed in Task 2.1 and Task 2.2 includes the data on soil, climate, land cover and information related to farming systems separately for Europe and China.

Regarding soils, Soilgrid 1 km (250 m lateron), Soil Geographical Database of Eurasia (1:1,000,000) were used. For climate, global Köppen Geiger and Worldclim data were used, respectively at 0.5 degree and 30 arc-second resolution. Land cover information was obtained from CORINE (100 m resolution) for Europe and from GLC30 (30 m resolution) globally. Cropland data of different crops was obtained at 5 arc-minute resolution while gridded livestock data was obtained at 3 arc-minute resolution.

I. Harmonization of datasets for further assessment was performed:

- Formats of the datasets were harmonized, for spatial extent and geographical projection taking thematic details into account.
- Data regarding Europe and China was derived from continental/country and global datasets.
- CORINE 2000 was used for those European countries where CORINE 2006 was not available.

II. Data from European and Global sources is available for project partners through intranet. Harmonised datasets can be accessed at: iSQAPER.georgikon.hu
Tasks 2.1 and 2.2 were finalised with the production of Milestone report M2.1, which provides further details about the results.

Task 2.3. Establishment of pedo-climatic zones by integrated analysis of soil water and nutrient dynamics and climatic factors (Lead partner: JRC, partners: ISRIC, UP, ISS)

Task description

Pedo-climatic zones of Europe and China will be delineated on the basis of biophysical determinants of net primary productivity. A multi-scale hierarchical approach will be applied, where soil water and nutrient characterises will be assessed within main climatic zones and in relation to prevailing climatic conditions within the zones. In order to secure consistency between different pedo-climatic zones, numerical approaches including data mining techniques will be applied. Main constituents of pedo-climatic zones will include soil water budget and nutrient dynamics. Both primary data (for example measured P levels) and modelled data (for example standardized precipitation evapotranspiration index - SPEI) will be used.

Activities and results

The aim of the current pedo-climatic zonation was to support the interpretation of soil resources by providing detailed pedo-climatic data that can be later used for studies on optimizing land use for local climatic and soil conditions. For that aim we analysed the combination of climatic zones with soil information of Europe and China. The spatial extent of Reference Soil Groups represent the major units of pedo-climatic zones. The delineation of pedo-climatic zones is based on regional soil differentiation rules, both in China and Europe.

Scale-dependency of different levels of pedo-climatic zones is a key issue. To answer the challenge to provide more information with increasing accuracy when turning to finer scales in the assessment, pedo-climatic zones were subdivided by detailed pedological information. Differentiation was achieved by introducing second-level soil qualifiers within the pedo-climatic zones which hold information on potentials of soil water and nutrient status and dynamics. According to the subordination of regional level, a hierarchical system is established to better understand the basic situation of soil resources, and analyse the status quo and potential. This approach secures the basis for the second level of the multiscale assessment. Numerical approaches are applied to characterise the spatial extent of pedo-climatic zones in a comparable manner in China and Europe. Further semantic details should be introduced based on detailed information based on case studies, including primary data, such as measured nutrient (NPK) levels.

Figures 1 and 2 show respectively the resulting maps of pedo-climatic zones for Europe and China. Further details on the establishment and the analysis of pedo-climatic zones can be found in Deliverable 2.1.

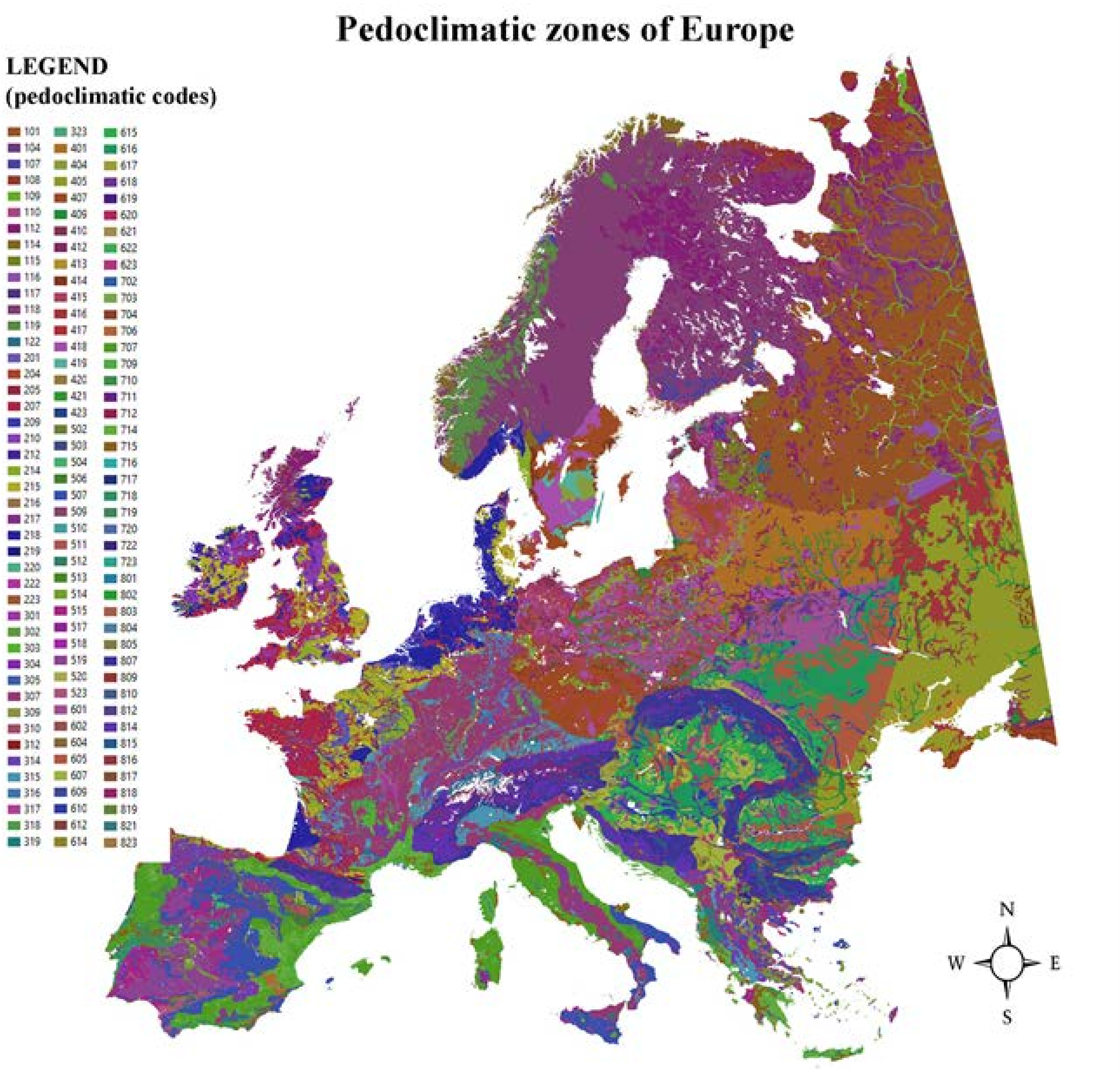

Figure 1. Pedo-climatic zones of Europe

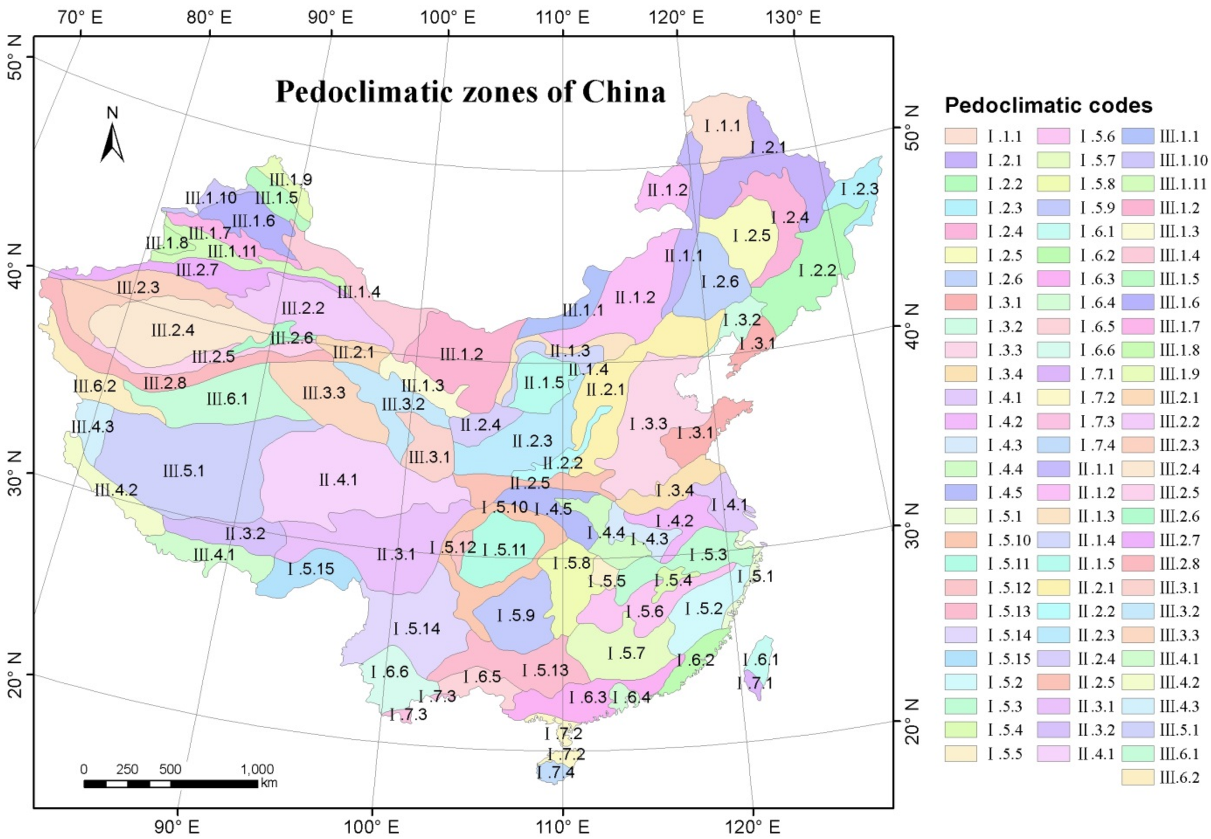

Figure 2. Pedo-climatic zones of China

Task 2.4: Classification of farming systems across Europe and China (Lead partner: UP, partners: JRC, ISS, Case Study Sites)

Task description

The classification of farming systems has been traditionally based on the available natural resource base and the dominant pattern of farm activities and household livelihoods, taking into account the main technologies used, which determine the intensity of production and integration of crops, livestock and other activities. Different approaches to farming system classification will be tested and the best-for-the-purpose classification will be integrated with the pedo-climatic zones concept. Apart from traditional farming system classifications, which are based on combined land cover and land use descriptions, the feasibility of management-based classification will also be assessed. Hierarchical classification will be provided to enable multi-scale analysis as well as to facilitate the implementation of the Soil Quality app in diverse environmental conditions in a clear, hence comprehensive structure.

Activities and results

The aim of this task was to derive a classification of farming systems including categories on which spatial datasets have information, which provides the possibility for spatial analysis of farming systems in Task 2.5.

Different approaches to farming system classification were analysed and the best-for-purpose classification was integrated with the pedo-climatic zones concept. After critical review of different approaches to farming systems classification, we defined farming systems for the purpose of the iSQAPER project as the "representation of the combination of cropping and livestock activities and the resources available (pedo-climatic conditions) to the farmers to raise them for their production purposes”.

The proposed classification of farming systems groups practices is based on the most important land use types including plant and animal breeding, under the highest categories of Arable land, Permanent Crops, Pastures and Livestock systems (see Table 1). Details on the elaboration of the classification scheme are provided in Deliverable 2.2.

Table 1. Farming system classification of iSQAPER

	Farming systems	
	Cropping systems	
1. ARABLE LAND*	1.1. Cereals: wheat, barley, sorghum, others (millets, oats, etc.)	1.1.1. Cereals, non-irrigated 1.1.2. Cereals, irrigated
	1.2. Rice	1.2.1. Rice, non-irrigated 1.2.2. Rice, irrigated
	1.3. Maize	1.3.1. Maize, non-irrigated 1.3.2. Maize, irrigated
	1.4. Legumes: soybean, peas, been, lentil, pulses other: groundnut, pigeon pea, cowpea	1.4.1. Legumes, non-irrigated 1.4.2. Legumes, irrigated
	1.5. Oil crops: sunflower, oilseed rape, others	1.5.1. Oil crops, non-irrigated 1.5.2. Oil crops, irrigated
	1.6. Fodder crops: alfalfa, red clover, other fodder crops	1.6.1. Fodder crops, non-irrigated 1.6.2. Fodder crops, irrigated
	1.7. Root crops and tubers: potato, sugar beet, other; sweet potato, yam	1.7.1. Root crops, non-irrigated 1.7.2. Root crops, irrigated
	1.8. Fallow	
2. PERMANENT CROPS	2.1. Vineyards 2.2. Fruit trees and berry plantation 2.3. Olive groves 2.4. Banana 2.5. Oil Palm 2.6. Tea 2.7. Sugarcane	
3. PASTURES	3.1. Extensive 3.2. Intensive	
	Livestock systems	
4. LIVESTOCK specialisation	4.1. Dairy cattle 4.2. Beef and mixed cattle 4.3. Sheep and goats 4.4. Pigs 4.5. Poultry	

Task 2.5: Analysis of farming systems in the pedo-climatic zones (Lead partner: UP, partners: JRC, UPM, ISS, Case Study Sites)

Task description

Extent and spatial patterns of different farming systems in the pedo-climatic zones will be analysed. The analysis will cover comparative assessment of current farming systems on regional and continental scales including soil resource utilisation of different farming systems. Needs and gaps will be explored, with special attention to soil quality and nutrient management. Climate is recognized as one of the defining features of different farming systems; it follows that if the climate changes, farming system will have to shift, adapt, or be transformed into a different land use. The results of previous projects such as ECOFinders, RECARE, MyWater, CATCH-C, D-e-METER will also be utilised for this task.

Activities and results

There are no results to report yet on this task.

1.2.3 Work Package 3

Summary

In recent years a large body of work in the field of soil quality indicators has been produced by researchers in many areas of the world (EU-DESERTLINKS, EU-DESIRE, EU-ENVASSO, EU-ECOFinders, EU-Soilservice, various Visual Soil Assessments). National programs have attempted to identify the most effective combination of measured soil properties that provide an effective assessment of soil quality. However, there is not yet a consensus on the best combination of measurements to use for assessing agricultural soil quality, from the perspective of the essential soil functions (soil structure formation; litter decomposition; carbon cycling; nutrient cycling; water cycling) that sustain soil ecosystem services (production; water infiltration, storage and supply; erosion control; nutrient retention and supply; filtering and buffering of nutrients and contaminants; maintaining the soil greenhouse gas balance; maintaining the soil organic matter balance; soil-borne pest and pathogen control; and serving as a habitat). Factors including sensitivity to indicate soil threats and soil functioning and management interactions, cost, reliability, and simplicity, all need to be considered when selecting or developing a soil quality indicator system that is geared to land potential, i.e. to set goals for outcomes of soil functions to deliver ecosystem services.

In this work package we provide a critical review of existing soil quality indicators systems all over the world, and mine the existing data on soil quality as assessed in European and Chinese field trials to identify the best subset of measurements that could be used to develop (aggregate) indicators of agricultural soil quality for desired ecosystem services. This includes a compilation of soil quality concepts worldwide, accessing data from published literature, as well as raw data from ongoing field trials and the identification of knowledge gaps in the field of quality indicator systems. Data are analysed and results will be fed into WP4 for development of SQAPP. Knowledge gaps are identified during screening of (data underlying) existing indicator systems and early development of SQAPP. Where needed, additional experimental work will be carried out at long-term field sites to fill the most important knowledge gaps on how soil type, climatic zone, topography and crop and land management interact to affect soil quality parameters. The WP includes a core set of >30 existing long-term field experiments selected to represent both cropland and pasture/grassland systems on a range of soil types in the dominant European and Chinese climatic zones. Experiments in this WP are also used to screen newly developed indicators of soil quality.

The main objectives of WP3 are:

1. To critically review existing concepts of soil quality and soil health indicators (Task 3.1, D 3.1, month 16);

2. To document existing field trials across various pedo-climatic zones in Europe and China so as to (Task 3.2, D3.2, month 20):
    a. compile a database of research results in the field of soil quality and soil health indicators
    b. analyse the data to identify the indicators that are the most cost-effective in terms of sensitivity to indicate soil threats, soil functions and land potential
    c. identify knowledge gaps in the field of soil quality indicator systems to be used in SQAPP
3. To assess how soil type, climatic zone, topography and crop and land management interact to affect indicators of soil quality (Task 3.3, D 3.3 month 38);
4. To screen and evaluate a range of newly developed indicators of soil quality in long-term trials (Task 3.4, D 3.4 month 38).

Details for each task

Task 3.1: Critically review existing concepts of soil quality and soil health indicators (Lead partner: FiBL, partners: WU, JRC, UE, IARRP, AUA)

Task description

Soil physical, chemical and biological measurements are proposed in a series of soil quality and soil health concepts all over the world. An overview of such soil quality concepts was produced in 2009 in Switzerland by Agroscope and FiBL. We update this compilation in the frame of the proposed project, and evaluate the different soil quality indicators with respect to sensitivity to indicate soil threats, soil functions and land potential as well as reliability, simplicity and cost-effectiveness. The outcome of this task is a set of parameters which are used to assess soil quality in various pedo-climatic conditions in Europe and China. This set of parameters is used in a meta-analysis under Task 3.2.

Activities and results

Task 3.1 started with a collection of existing soil quality concepts, both in peer-reviewed journals and in reports. Definitions of important terms, namely soil quality/fertility/health and soil functions/processes, soil-based ecosystem services and soil threats were proposed and discussed during a workshop of WP2 and 3 at FiBL, Switzerland, October 12-14, 2015. This resulted in a conceptual framework (Figure 3) which shows the proposed linkages between soil-based ecosystem services, soil functions and soil threats.

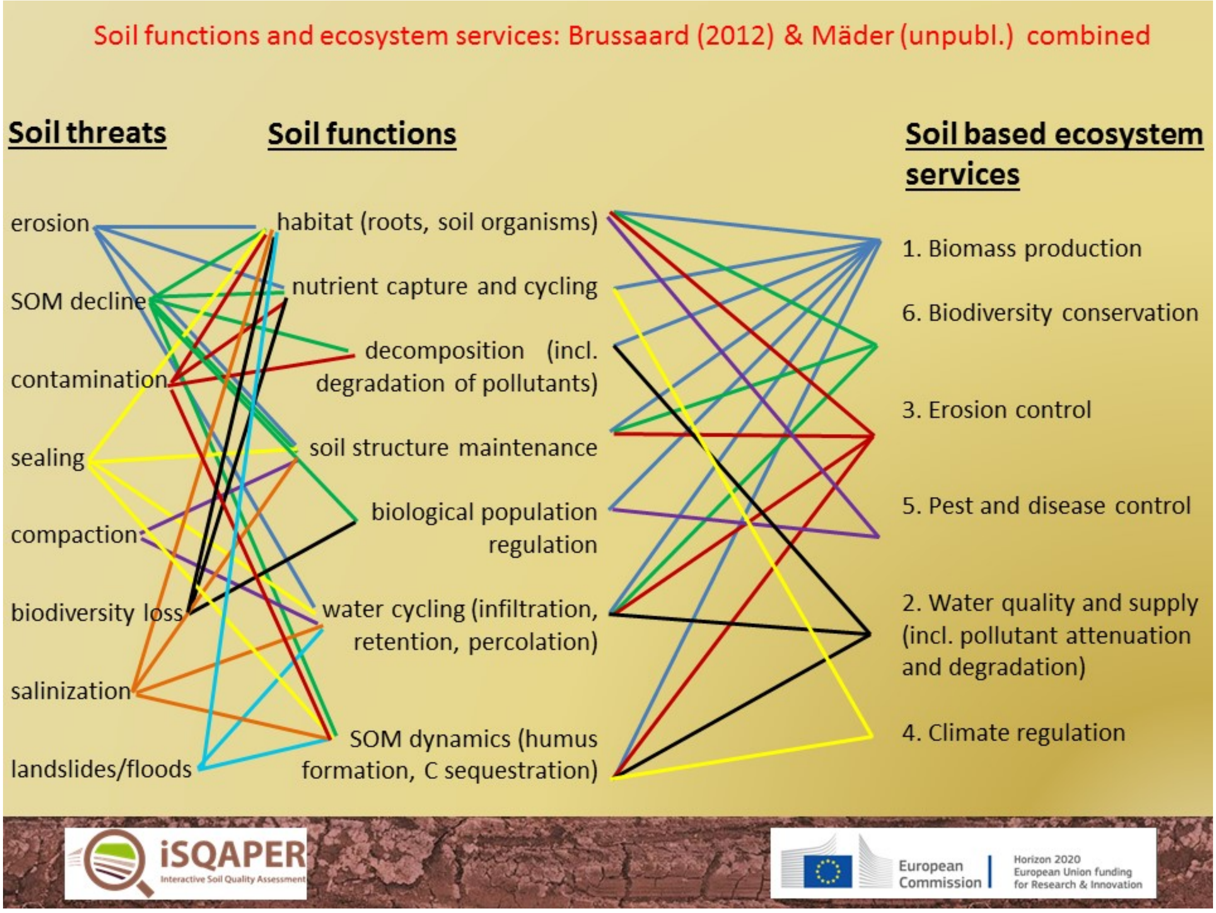

Figure 3: Conceptual framework of linkages between soil functions, soil-based ecosystem services and soil threats developed during the iSQAPER workshop at FiBL, Frick (October 2015)

Subsequently, 49 soil quality concepts from around the world were reviewed critically, from their objectives and target users to the proposed indicators and evaluation. In particular, the requirements given for the indicators were examined thoroughly, with the conclusion that such requirements are sometimes listed, but that an evaluation of how different measurements actually fulfil such requirements is typically missing. In particular, there is a need for experimental evidence in order to establish firm linkages between indicators and soil-based ecosystem services. A compilation of proposed soil quality indicators (Figure 4) identified the following indicators as the most frequently used: bulk density, particle-size distribution (texture), plant-available water and aggregate stability among the soil physical properties, total organic carbon, pH, available P and total nitrogen among the soil chemical properties, and soil respiration, nitrogen mineralisation, microbial biomass and earthworms among the soil biological properties.

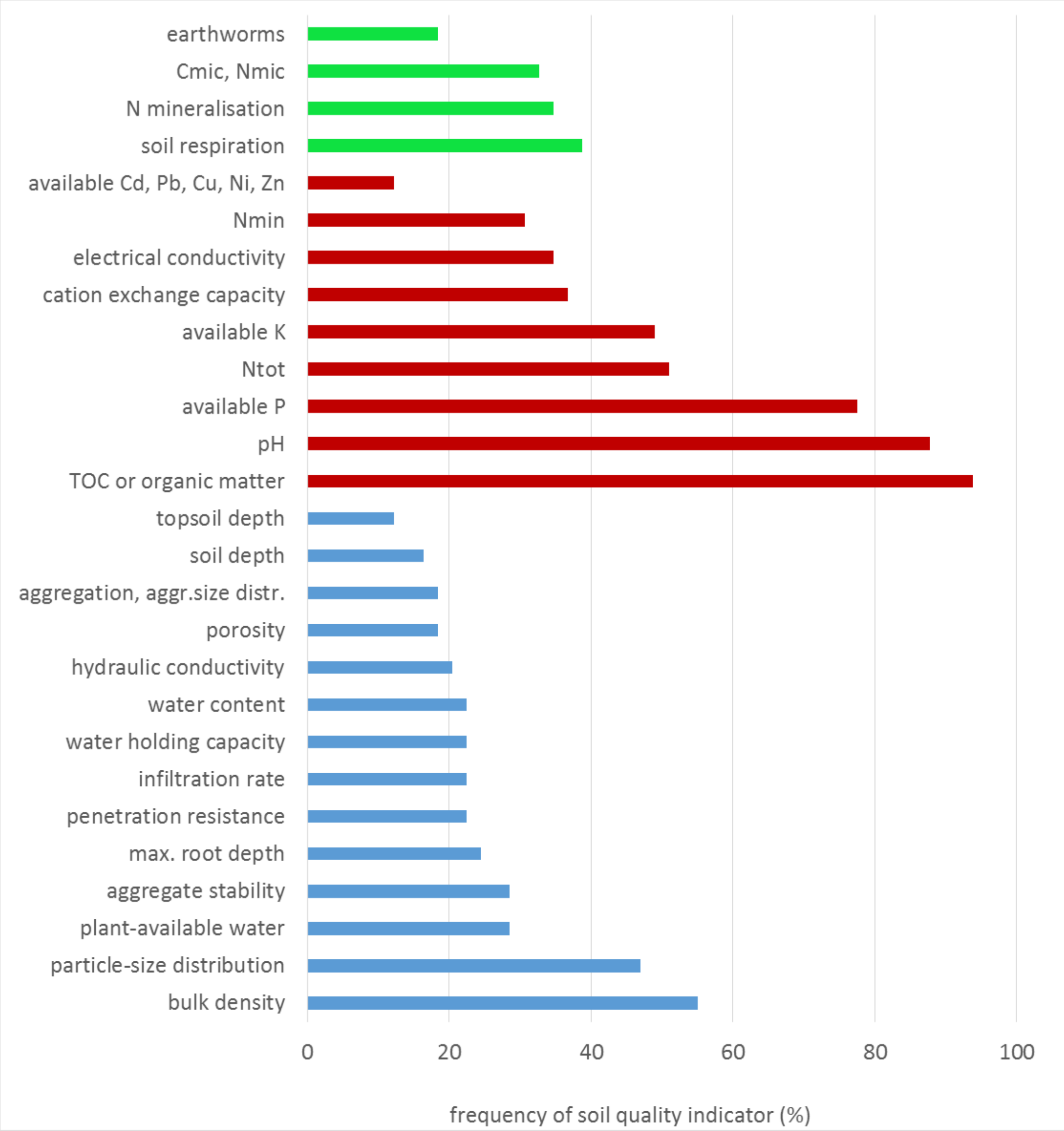

Figure 4: Frequency of different indicators (> 10%) in all reviewed soil quality concepts (n=49). Soil biological, chemical and physical indicators shown in green, red and blue, respectively.

In parallel, an exercise was conducted during the workshop of WP2 and WP3 at FiBL in October 2015 to use expert opinion for identifying indicators which best reflect the various ecosystem services (Table 2). Here, total organic carbon (or soil organic matter in general) was identified as the most often mentioned indicator, associated with 5 out of 6 ecosystem services. Texture and soil depth, pH, maximum rooting depth, dissolved organic carbon and water holding capacity were also considered to reflect 3 or 4 ecosystem services each.

Table 2: Indicators selected by group work during the iSQAPER WP2/3 workshop in Frick, October 12-14, 2015, to reflect a given soil-based ecosystem service. For example, pH was considered to reflect 3 out of 6 ecosystem services.

	SOM (TOC)	**texture / particle size distribution**	**soil depth / topsoil depth**	**pH**	**max. root depth / root distribution**	**DOC**	**water holding capacity**	**bulk density**	**mineral N / mineralisable N**	**biocontrol potential / natural enemies**	**nematode community**	**CEC**	**aggregate stability**	**molecular diversity**	**organic pollutants**
1. Biomass production	1	1	1	1	1	1	1	1	1			1			
2. Water quality & supply	1	1	1	1	1		1					1			1
3. Erosion control	1	1	1		1								1		
4. Climate regulation	1	1					1		1				1		
5. Pest & disease control	1					1				1	1			1	
6. Biodiversity conservation			1	1		1		1		1	1			1	1
Sum	**5**	**4**	**4**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

Table 3: Core set of soil quality indicators to be used in iSQAPER and suggested analytical and visual methodologies for each indicator

Indicator	**Available from maps or farmers**	**Analytical (laboratory) or quantitative method**	**Visual (field) or scoring method**
Available water		Pedotransfer function	
Bulk density	SoilGrids	Undisturbed volumetric sampling rings	Porosity estimate or spade diagnosis
Surface hardness / compaction		Penetrometry	Infiltration test or penetrometry or spade diagnosis
Subsurface hardness		Penetrometry	Presence of a cultivation pan or penetrometry or spade diagnosis
Soil stability		Aggregate stability (Kandeler 1996; >0.25 mm, wet sieving)	Soil structure, consistency observations plus slaking test or spade diagnosis
pH	SoilGrids	pH electrode (ISO 10390:2006)	pH kit
Soil organic matter (C)	SoilGrids	Dry combustion (ISO 10694) ; loss on ignition	Soil colour
Labile C		Various methods under evaluation	
N supplying capacity		N mineralization during aerobic incubation	
Extractable P	Soil P test	Olsen-P	
Extractable K	Soil K test	Ammonium lactate or ammonium acetate	
Earthworms		Handsorting in combination with use of mustard solution	Handsorting
Microbial activity		Respirometer	Tea bag test
Biomass production (aboveground)		Fresh and dry weight	
Disease incidence and suppression		Disease suppression test (under evaluation)	Disease incidence

Based on the literature review, the group work during the iSQAPER workshop and own experiences, the WP3 team selected a set of soil quality indicators to be used in the iSQAPER project (Table 3). These are currently evaluated in selected field trials in different pedo-climatic zones (Task 3.3). We suggest a combination of laboratory and field measurements which are partly alternatives so that users can choose between visual and analytical methods. We also established conceptual linkages between indicators, soil functions and soil-based ecosystem services to enable a targeted evaluation of soil quality, depending on the functions and ecosystem services of interest (Table 4).

A subset of the indicators listed in Table 3 was used to evaluate effects of management practices on soil quality indicators.

Table 4: Laboratory analyses and field assessments planned within iSQAPER WP3 as related to soil functions and soil-based ecosystem services.

			Soil functions							Soil-based ecosystem services					
	Indicator	**Analytical (A) or field assessment (F)**	**Habitat for roots and soil organisms**	**Nutrient capture and cycling**	**Decomposition (incl. pollutant degradation)**	**Soil structure maintenance**	**Population regulation**	**Water cycling**	**SOM dynamics**	**Food, feed, fibre production**	**Water quality & supply**	**Erosion control**	**Climate regulation**	**Pest and disease control**	**Biodiversity conservation**
Chemical	pH	A/F	x	x	x	x				x					
	SOM	A/F		x		x		x	x	x		x	x		
	Labile C	A												x	
	N supplying capacity	A		x						x					
	Extractable P	A		x						x					
	Extractable K	A		x						x					
Biological	Earthworms	A/F													x
	Yield	A								x					
	Microbial activity	A/F			x				x						x
	Disease suppression	A/F					x							x	
Physical	WHC, avail. water	PTF	x					x			x				
	Bulk density	A/F	x			x			x				x		
	Surface/sub-surface hardness	A/F	x							x					
	Soil stability	A/F				x						x			

The review of soil quality concepts yielded important conclusions towards the cornerstones of a new soil quality concept. As a first step, the objectives need to be clearly stated and target users named and involved in the process (Figure 5). Subsequently, indicators with clear linkages to targeted soil functions and ecosystem services should be selected. Here, flexibility with respect to used indicators, including substitute indicators or parallel lines of evidence, and considering soil indicators as well as non-soil indicators, would be an asset. Arguably, the most important part of a soil quality concept is then to establish a sound interpretation of each indicator as well as an aggregated overall rating of soil quality. Based on the previous steps, an interactive tool can be created that ideally will include management advice.

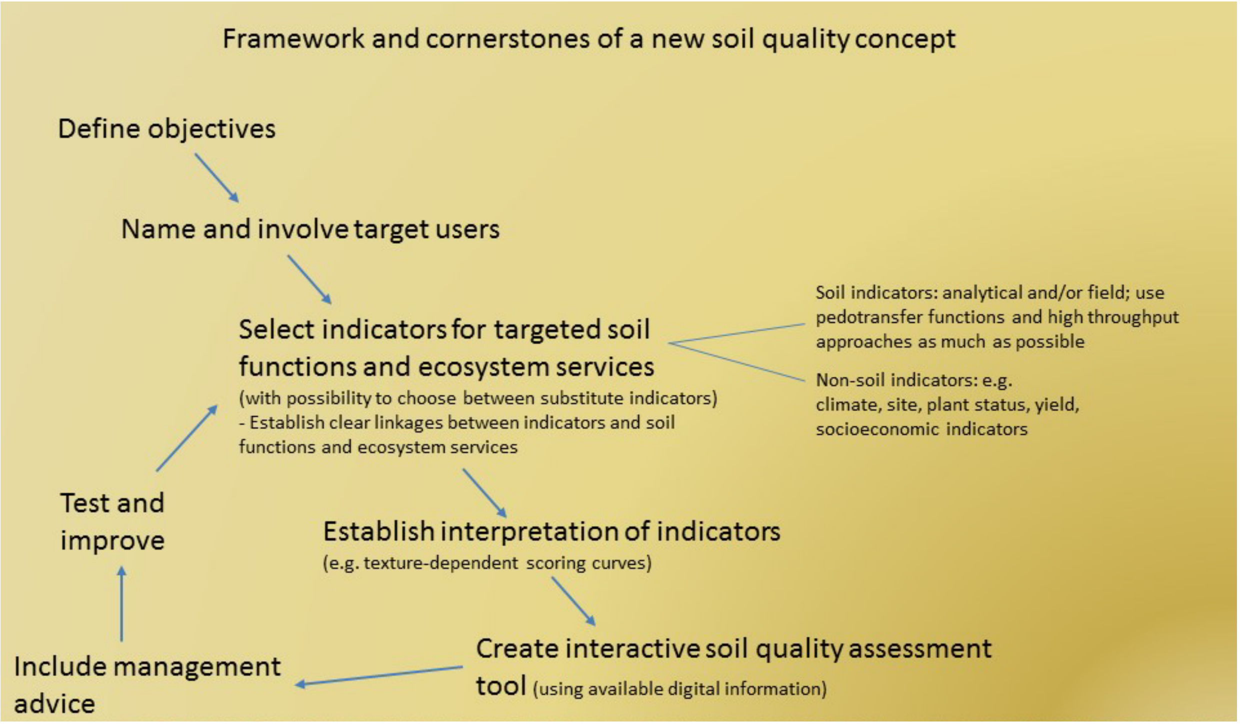

Figure 5: Framework and cornerstones of a new soil quality concept

Task 3.2: Documentation of existing field trials across various pedo-climatic zones in Europe and China (Lead partner: ISRIC, partners: FiBL, WU, DLO, IARRP, All partners with long-term field experiments)

Task description

a. compile a database of research results in the field of soil quality and soil health indicators
b. analyse the data to identify the indicators that are the most cost-effective in terms of sensitivity to indicate soil threats, soil functions and land potential
c. identify knowledge gaps in the field of soil quality indicator systems to be used in SQAPP

This task documents the >30 long-term field trials contributed by the consortium members, complemented with other existing trial data. We build on a field trial overview generated in an ERA-NET project (Reduced tillage and green manures for sustainable organic cropping systems (TILMAN-ORG) on effects of conservation tillage on soil quality. Moreover we include key study sites which are part of EXPEER (FP7 project: Experimentation in Ecosystem Research) and from a database of the EU project Catch-C (Compatibility of Agricultural Management Practices and Types of Farming in the EU to enhance Climate Change Mitigation and Soil Health). The trials are characterized by site conditions (soil type, climate) and management practices (crop/animal production system, crop rotation, fertilisation, plant protection and tillage).

Data of published and unpublished results on effects of management practices on soil quality indicators in view of key soil functions such as carbon sequestration, nutrient cycling, soil structure formation and pathogen/pest suppression are fed into a database.

A literature review/meta-analysis is conducted on effects of various management practices on key soil quality and soil health indicators using assembled data from the field trials, distinguishing between major European and Chinese climatic zones, soil type, topography and land use (arable, vegetable, grassland, permanent crops) as defined in WP2. The soil quality and health indicators are evaluated with respect to their sensitivity to indicate soil threats and soil functions and interactions with management as well as reliability and simplicity of measurement. They is also be linked with yield data.

Knowledge gaps are identified, in particular in the field of soil biotic community assessment, soil root symbioses, and the capacity of soils to suppress plant pathogens and soil fatigue, as well as with respect to methods for assessing plant-available soil nutrients and soil structure and the soil's potential to sequester, retain or loose carbon and nutrients as greenhouse gases or other forms causing environmental stress.

Activities and results

Documentation of LTEs

In the iSQAPER project, long-term field experiments (LTEs) are the key asset to study the effects of agricultural management practices on soil properties. In order to get an overview of past and current LTEs existing with the project partners, we designed a template and sent it out in October 2015 to 13 partners from Europe and China to collect information on their LTEs, including location, climate, land use, soil information, trial factors, management systems, assessments done, sample storage, and related publications. We compiled the information in a MS Excel and analysed it, resulting in Milestone (M3.1, submitted December 2015): "*overview of major existing field trials across various pedo-climatic zones in Europe and China and database of research results in the field of soil quality indicators*". The main findings were:

- Duration of the LTEs: 36 LTEs were documented (Table 5), with the earliest starting in 1964 and with all LTEs still on-going except for Braila (RO) and Vitaqua (ES). The total number of years of all LTEs is 728, with an average duration of about 20 years, and 25 out of the 36 LTEs have been running for more than 10 years.
- Geographic distribution of LTEs: Figure 6 shows the geographic location of the LTEs across Europe and China: 29 experiments from 10 European partners and 7 experiments from 3 Chinese partners. Altitude a.s.l. ranges from -2 m (in the Netherlands) to 1425 m (on the Chinese Loess Plateau). The fact that iSQAPER partners were chosen for scientific rather than geographic reasons explains why the LTEs in Europe are unevenly distributed and mostly clustered within locations. For Europe, additional LTEs in France and Italy would have helped to reach a more complete coverage. For China, the 7 LTEs cover different pedo-climatic zones, from sub-tropical in the south to continental with dry winters in the north-east.
- Land use: The focus of iSQAPER is on agricultural soil quality. Not surprisingly, 20 of the experiments are under arable farming, 11 under pasture, and 5 under permanent crops (wine). This is also reflected by the main soil function targeted in a given LTE: Productivity

was chosen 25 times, far ahead of erosion control (4), biodiversity conservation (3), and water quantity/quality (1).
- LTE environmental conditions: The European LTEs are covering all major climatic zones. The only larger zone missing, i.e. Cfa (Humid subtropical), can probably be substituted by two experiments in China. In China, climate zones are evenly represented by the seven LTEs, from the warmer/wetter climatic zones in the south, moderate in the centre and dry-cold in the north-east. The majority of sites is in flat to slightly undulating terrain. Exceptions are two sites in Greece and the Loess Plateau in China with slopes of >15% on average. There is quite some diversity in terms of soil types. Younger soils (Regosols, Cambisols, alluvial soils) are equally represented as soils in more advanced stages of developments (Luvisols, Acrisols). All soil textures are represented, with a tendency towards coarser particle sizes (sandy loam, loamy sand). The top three soil threats encountered at the sites are SOM loss (12), erosion by water (5), and physical degradation (4).
- Soil quality indicators: The documentation provides a comprehensive overview of which parameters have been assessed or are being assessed, *i.e.* are being considered adequate soil quality indicators by the iSQAPER partners. As expected, there is not one single parameter for which data is available from all LTEs. Nevertheless, soil organic carbon, soil pH and texture have been assessed in most experiments. The lack of a homogeneous dataset from all LTEs clearly established the need for the sampling campaign conducted in Task 3.3.

Table 5: Overview of LTEs contributed per iSQAPER partner

iSQAPER partner	Total number of...		
	LTEs	Experimental years	Measurements of parameters[1]
FiBL (CH)	3	55	62
DLO (NL)	4	36	68
IA (PL)	1	14	7
IAES (EE)	3	102	47
UL (SI)	2	20	18
ICPA (RO)	1	3	9
ESAC (PT)	5	41	20
UMH (ES)	4	55	40
AUA (GR)	2	31	19
IAARP-CAAS (CN)	4	110	39
ISWC-CAS (CN)	2	56	12
SFI (CN)	1	34	11
UP (HU)	4	171	45

[1] excluding very unusual parameters

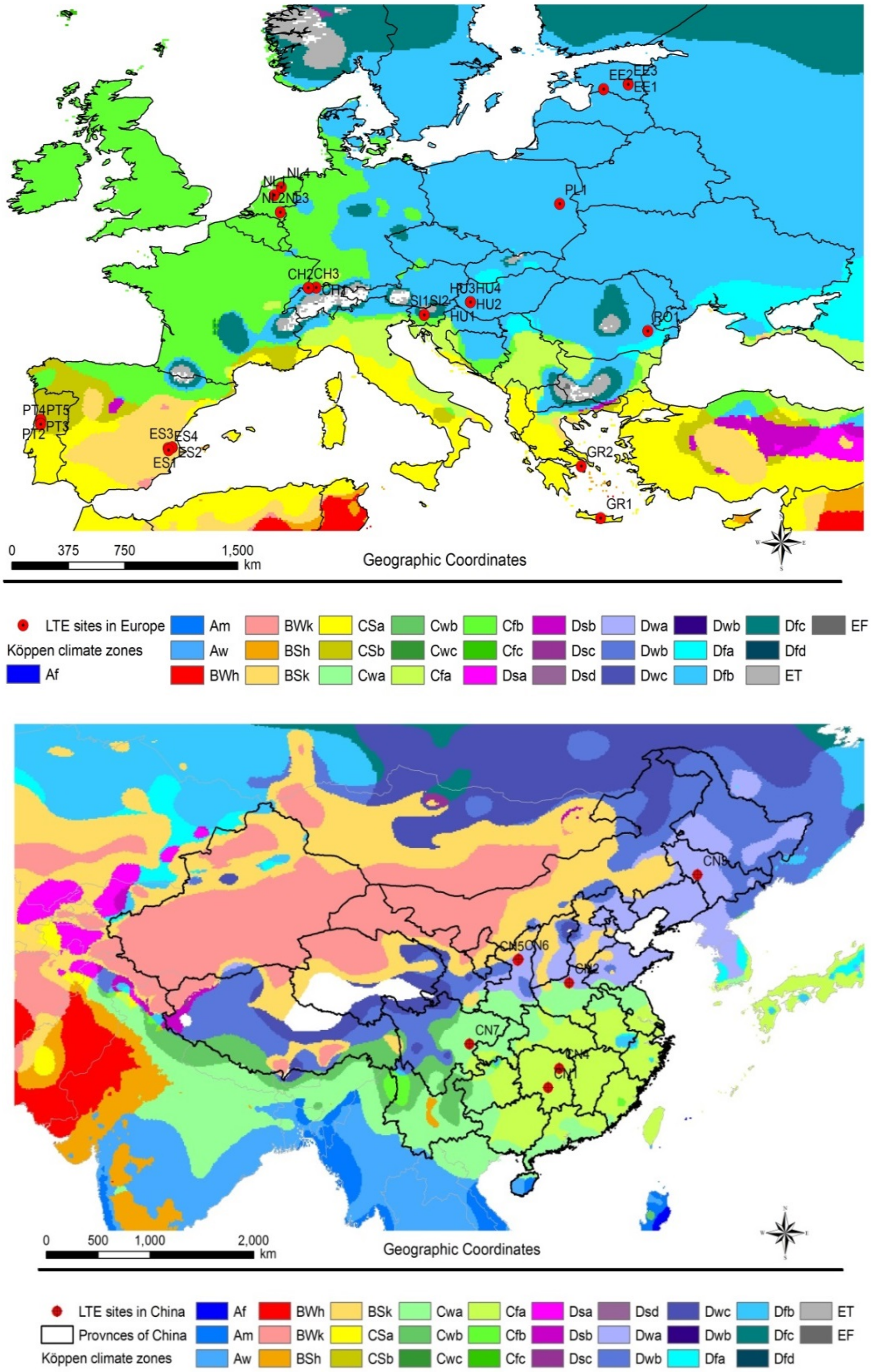

Figure 6: iSQAPER LTE sites in Europe (top) and in China (bottom); Köppen-Geiger climatic zonation is used as a backdrop.

Collection of LTE data

We analysed the usefulness of each LTE for the project based on criteria such as minimum overall duration and availability of true field replicates. We designed a template in MS Excel along with a filled-in example, which we sent in early December 2015 to the owners of all relevant LTEs for entering actual data. The template included an 'instruction' how to fill in the template with the worksheets 'experiment', 'soils', 'climate', 'treatments', 'management' and 'measurements'. We received data from 30 out of the 36 documented LTEs (6 LTEs were identified as being not relevant to the project or having no data). We compiled all collected LTE data in a MS Excel. In parallel, we supplemented this dataset with results from other LTEs across the world that have been traced through completed EU projects such as TILMAN-ORG, a Chinese LTE network or literature studies. Both the data from within and beyond iSQAPER were used for further analyses.

Literature review/meta-analysis

To analyse effects of agricultural management practices on soil quality indicators and to assess the sensitivity of the indicators for soil functions and soil threats in major pedo-climatic zones of Europe and China, we chose six key soil quality indicators, namely soil organic matter/carbon (SOM/SOC), pH, aggregate stability, water holding capacity, earthworms and yield. We examined these indicators under five paired management practices, *i.e.* organic matter addition versus no organic matter input, no-till versus conventional tillage, crop rotation versus mono-cropping, irrigation versus rainfed farming, and organic versus conventional agriculture.

We analysed trends of the indicators and their relative changes under the paired practices based on the collected LTE data. In addition, we collected over 900 peer-reviewed papers and reports using various web-based search engines, and entered the evidence presented in the literature (some 400 references) into a literature review database (LR-database). We calculated a ratio for each indicator for a given paired-practice, for example, soil organic carbon (SOC) content under no-till divided by SOC content under conventional tillage for each LTE. Subsequently, descriptive statistics for the indicators under the paired practices were analysed using an R-script. Medians were of the ratio distributions were visualised in flower petal diagrams for each paired practice: a value of 1 indicates no change (blue line), a value > 1 indicates a 'positive' change (increase), and a value < 1 a 'negative' change (decrease); the magnitude of the trend depends on the median values. For most indicators, a median > 1 is considered favourable from a soil quality perspective. For pH, results have to be interpreted more cautiously, i.e. dependent on the soil type and in view of the log scale. Colours for the flower petals are assigned as: dark grey if the number of observation is less than 2; all other colours are assigned if the number of observations is equal to or more than 2: orange, when the median is less than or equal to 1; light green, when the median is larger than 1 and less than 1.5; dark green, when the median is larger than 1.5.

This results of the literature review/meta-analysis are presented in Deliverable D3.2 (month 20, November 2016). Selected results are shown below.

<u>*Organic matter addition versus no organic matter input*</u>

Organic matter (OM) addition favourably affects all the indicators under consideration as shown in Figure 7. The most favourable effects are reported for earthworms numbers, followed by SOC, yield and soil aggregate stability. OM addition enhances soil water holding capacity. For pH, the effects depend on the soil type. For example, OM input may favourably affect the pH of acidic soils.

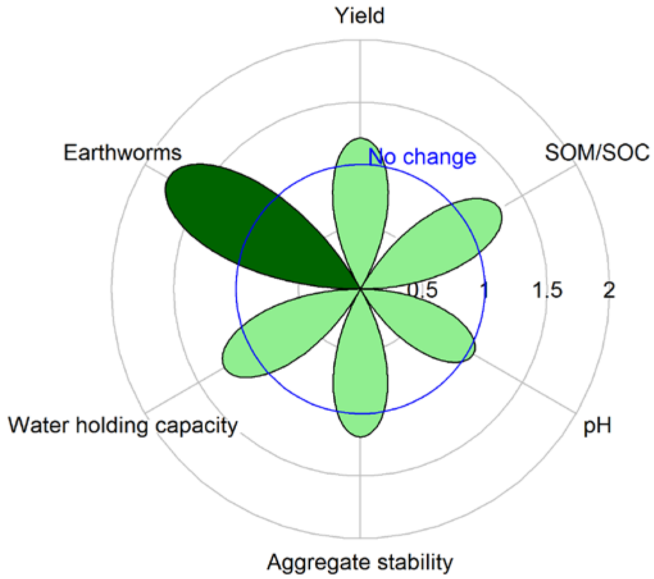

Figure 7. Long-term effects of organic matter addition on soil quality indicators compared to no organic matter input, expressed by a median of ratios.

<u>*No-till versus conventional tillage*</u>

There is no clear trend for the effect of no-till (NT) on soil pH. According to the evidence analysed, NT generally leads to increased aggregate stability and greater SOM content in upper layers. Compounded, these effects are reflected in a greater water holding capacity. However, the magnitude of the relative effects varies *e.g*. with soil texture. No-till practices favourably affect earthworm populations, yet not in regions where herbicides or pesticides are needed to combat weeds and pests, respectively. Overall, in this review, yield decreased slightly under NT compared to conventional tillage (Figure 8).

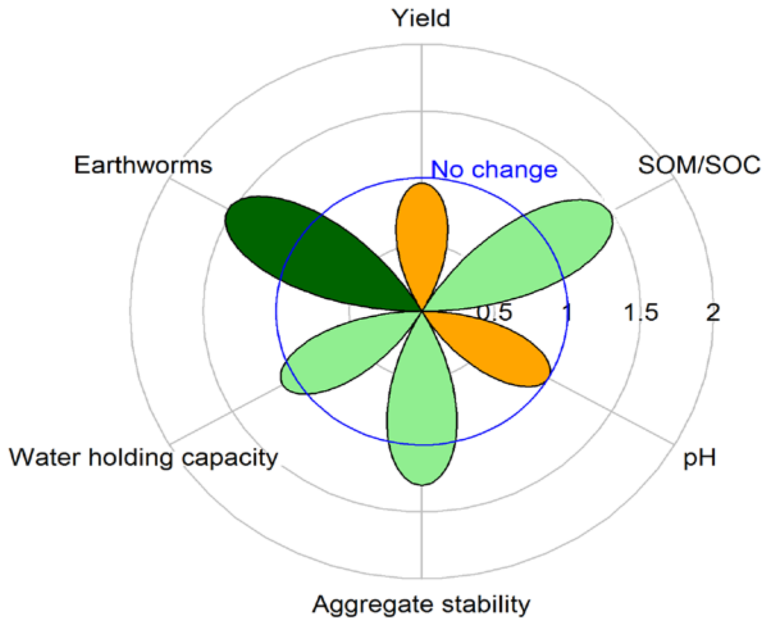

Figure 8. Long-term effects of no-till on soil quality indicators compared to conventional tillage, expressed by a median of ratios.

Crop rotation versus mono-cultivation

Crop rotation has a positive effect on SOM/SOC and yield. Overall, crop rotation has little impact on soil pH, aggregate stability and water holding capacity. Mixed effects on earthworm numbers were observed in this review; overall, the effect is unfavourable (Figure 9).

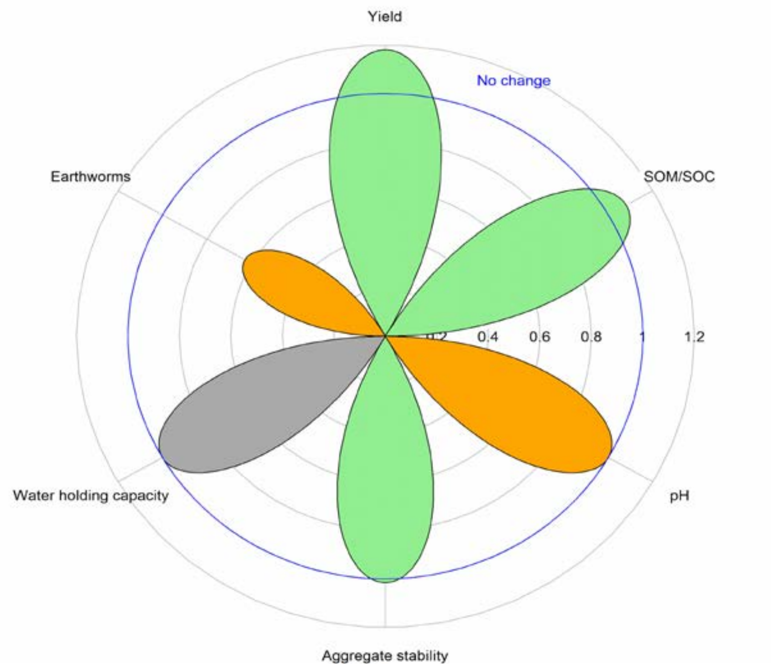

Figure 9. Long-term effects of crop rotation on soil quality indicators compared to mono-cropping, expressed by a median of ratios.

Irrigation versus rain-fed farming

Relatively few studies were available for this assessment. Figure 10 shows the impact of irrigation on the selected soil quality indicators: irrigation increases earthworm populations, aggregate stability and SOC. No clear trends were observed for soil pH and water holding capacity, as such effects are strongly dependent on soil type, amendments used, and quality of irrigation water. Irrigation, when properly implemented, increases yield.

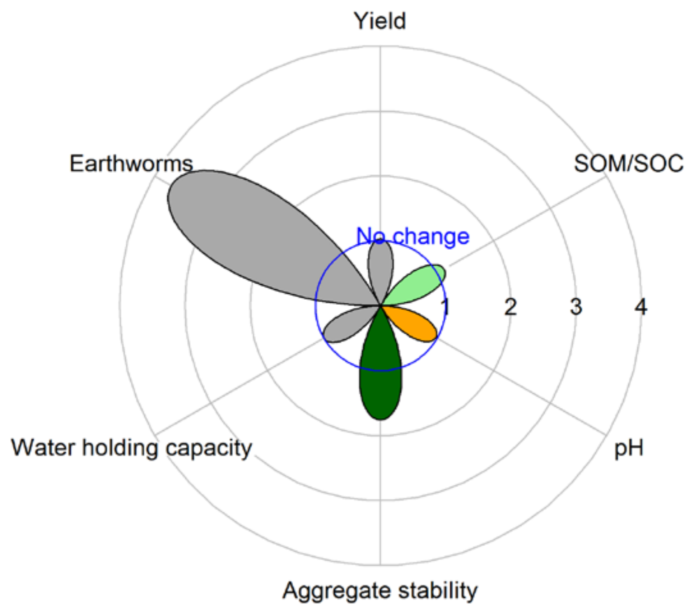

Figure 10. Long-term effects of irrigation on soil quality indicators compared to rain-fed agriculture, expressed by a median of ratios.

Organic versus conventional agriculture

A clear positive trend was observed for earthworm abundance under organic agriculture. Further, organic agriculture generally resulted in increased aggregate stability and greater SOC content. Overall, no clear trend was found for pH and water holding capacity. A decrease in yield was observed, in accordance with published meta-analyses (Figure 11).

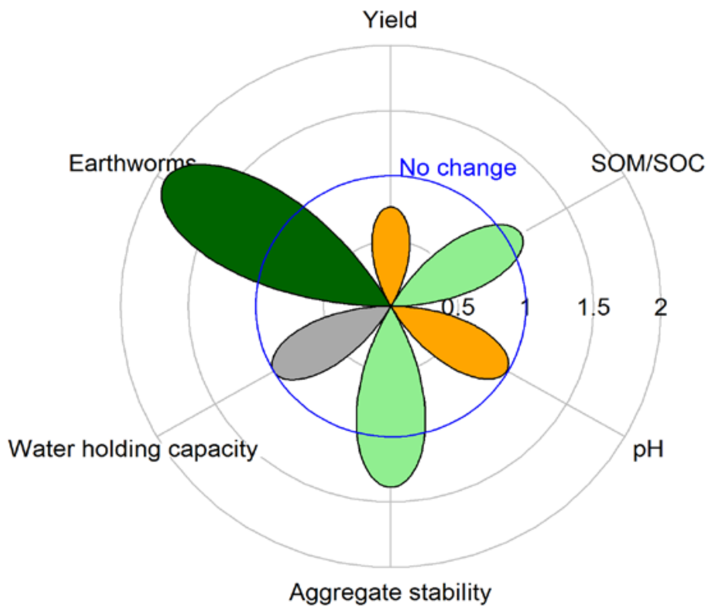

Figure 11. Long-term effects of organic agriculture on soil quality indicators compared to conventional agriculture, expressed by a median of ratios.

Suitability of the chosen soil indicators as a measure of soil functions

Overall, the selected soil quality indicators appear to be good indicators for the soil functions defined in the iSQAPER project. Soil quality is best assessed by soil properties that are neither so permanent as to be insensitive to management, nor so easily changed as to give little indication of long-term alterations. The six indicators chosen for this meta-analysis are sensitive to variations in agricultural management practices reported for long-term changes in soil quality in the iSQAPER partner countries. As such, these indicators are suitable measures for the corresponding soil functions. Although no clear trend in soil pH was observed for most practices, except for organic matter input, pH is still considered a useful parameter for evaluation of overall soil quality as it is a measure for changes in soil acidity hence crop growth. Concerning SOM, it may be important to consider long-term changes in pool sizes in relation to the desired ecosystem services (*e.g.* crop production versus carbon sequestration relating to climate change mitigation/adaptation).

Sensitivity of the soil quality indicators to soil threats

Few linkages of the soil quality indicators and soil threats under consideration were found. Only SOM/SOC and yield are good measures for the considered threats. None of the indicators appears to be suitable for soil sealing. The usefulness of the indicators varies depending on the nature of the threat, for example, soil pH can be a suitable indicator for acidification and salinisation.

Possible limitations

Trends for the indicators and their relative changes under the paired practices were determined based on the collected long-term experiment data, analytical data from the 42 LTEs in China, and reviewed studies. It is possible that some important works were not considered in this desk study.

Conclusions/Recommendations

All the discussed management practices affect soil quality indicators reviewed in this report, but they do this in various ways. Overall, there are clear trends and relative changes in the six indicators under the five paired practices. However, the magnitude of the trends and direction of change vary with crop species, climate zone and soil type. In particular, the influence of irrigation on soil pH and water holding capacity is not clear as it is strongly dependent on soil type and quality of irrigation water.

Earthworms appears to be the most sensitive indicator for all the discussed management practices; however, the magnitude of the trends and directions of change vary with climate zone, soil type and crop species. SOC/SOM responds positively to all the practices after 23 years (on average in this study) in comparison with the references. Water holding capacity, aggregate stability and yield are less sensitive to the practices and pH appears to be the most insensitive indicator.

Five paired practices were analysed for their impact on soil quality indicators and relative changes compared to the reference (control) practice. Some practices were generalized, e.g. organic matter input, even though there are various types of organic matter, for example farmyard manure, green manure, crop residue, and slurry, which will have different effects on soil quality indicators. Although such aspects were documented in the LR-database and text, they could not be included explicitly in the synthesis. For this, a full scale metadata analysis would be required, which was beyond the scope of this study.

Some management practices had negative effects, e.g. a decrease in yield under organic farming compared to conventional farming. At the same time, there are also positive aspects under organic farming such as higher marketing price and reduced environmental damage. Therefore, to evaluate whether it is judicious to convert conventional farming to organic farming, socio-economic aspects should be considered in combination with the biophysical conditions.

Results presented in this review may be used as a reference or input in other work packages, especially for WP 4, the development of a soil quality-based mobile phone app (SQAPP). Future work should also consider the following indicators of soil quality, even though they may not be routinely measured: slope, drainage, soil depth, stoniness, and soil colour. It should be noted that farmers often know very well which specific soil parameters are particularly relevant for their situation. Therefore, the view of land managers should be taken into account when evaluating various sets of indicators for soil quality. This would require a transdisciplinary and participatory approach.

Information on pesticide application

At request of the iSQAPER project coordination team, we collected additional data on pesticide application at the LTE sites. To do that, we created a template and asked experts in the field of pesticide application to review it, and sent it to each LTE owner with prefilled treatment numbers and experimental years that were provided in the earlier data collection. The LTE owners were asked to provide pesticide (herbicide, fungicide, insecticide) name, active ingredient, concentration of active ingredient and total input). We received information from 19 LTEs where pesticide are applied, and compiled the information into a MS Excel.

Task 3.3: Assess how soil type, climatic zone, topography and crop and land management interact to affect indicators of soil quality (Lead Partner: DLO, partners: FiBL, WU, UE, ISRIC, IARRP)

Task description

The field trials selected are expected to exhibit a range in soil quality status based on their differing histories and local pedo-climatic conditions. In this task an inventory of the current soil quality status in the selected field trials will be conducted using indicators selected in Task 3.2. This overview will provide important information about typical ranges for soil quality indicators in the different cropping systems and pedo-climatic zones. It will also provide an indication of how soil type, climatic zone, topography and crop and land management interact to affect indicators of soil quality. An additional output will be an evaluation of the indicators proposed in Task 3.2 and recommendations about their applicability in different pedo-climatic zones and crop(/animal) production systems. Validated indicators will be used for the assessment of soil quality by SQAPP in all experiments and on-farm evaluations (WP5 and WP6).

Activities and results

Task 3.3 started in month 12 and is ongoing until month 38
These tasks have been completed:

- Selection of indicators to be assessed in Long Term Experiments in Europe
- Selection of LTEs and treatments in which the selected indicators are assessed
- Selection of central labs for analysis of LTE samples
- Protocols and description of methods for soil sampling, storage and transport of samples, measurement of on-site indicators and lab analysis
- Soil sampling per LTE and transport of samples to central labs and assessment of indicators by the central labs
- Central gathering of soil indicators assessed by the central labs
- Sending the lab results to trial owners for validation
- Development of templates to fill in the data for the on-site measurements
- Measurement of on-site indicators according to the protocols
- Central gathering and validation of indicators assessed on site (still ongoing)
- A similar sampling campaign is planned in Chinese LTEs in 2017 (led by IAARP)

Central gathering of soil indicators assessed by the central labs
Based on Task 3.1, a selection was made of indicators to be assessed in central laboratories (Table 6) and on site (Table 7). Additionally, two soil quality indicators (aggregate stability and particulate organic matter as one method for labile carbon) were assessed in the MSc thesis of Jennifer Meier conducted under the supervision of Else Bünemann at FiBL, Switzerland. Soil respiration was determined on all samples by UMH (Fuensanta García Orenes). Novel soil biological indicators were assessed under Task 3.4 on samples from the same sampling campaign. In order to establish whether near-infrared (NIR) analysis could be a reliable and cheap alternative for the assessment of a number of chemical indicators, a selection of the samples were analysed by Eurofins, the Netherlands. Additionally, subsamples were taken to analyse pesticide residues in the soils of the LTEs (Violette Geissen, Wageningen University) based on the information on pesticide application collected in Task 3.2, i.e. on a subset of samples.

Table 6. Selection of indicators to be assessed in central labs

Indicator	**Method**
Chemical	
Total organic C	SIST ISO 10694: Soil quality -- Determination of organic and total carbon after dry combustion (elementary analysis): (for soil samples with pH < 6.7); SIST ISO 14235 Soil quality -- Determination of organic carbon by sulfochromic oxidation (for soil samples with pH ≥ 6.7)
Total N	SIST ISO 13878:1999: Soil quality - Determination of total nitrogen content by dry combustion ("elemental analysis").
pH	SIST ISO 10390:2006: Soil quality - Determination of pH
Plant-available P	ÖNORM L 1087 - modification: amon-lactate extraction
Cation Exchange Capacity, including available K	amon-acetate extraction; Soil survey laboratory methods manual, 1992
Biological	
Microbial biomass (CFE) including labile C	Chloroform-fumigation-extraction
Net N mineralization	Aerobic incubation 21 days
Physical	
Particle-size distribution	SIST ISO 11277:2011: Soil quality - Determination of particle size distribution in mineral soil material - Method by sieving and sedimentation

Table 7. Selection of indicators to be assessed on-site in the LTEs

Indicator
Biological
Earthworms (number and biomass)
Tea bag test (for decomposition)
Disease incidence (soil-borne diseases, when occurring)
Physical
Bulk density
Penetration resistance
Soil depth
Spade diagnosis
Yield
Net fresh and dry matter yield of main products and co-products (straw)

Selection of LTEs and treatments

We selected a range of LTEs varying in climatic zone, soil types, crop type and land management were selected (Table 8). The information for the selection of LTEs was based on the documentation of existing field trials in Europe gathered in Task 3.2. We used the following criteria for selection of LTE's and their treatments:

- Ongoing experiment
- Preferably 3-4 replicates
- At least one LTE in each pedo-climatic zone
- Different land uses available in the total set of LTEs
- Different soil types available in the total set of LTEs
- Variable soil threats available in the total set of LTEs
- Variable management and treatments systems in 1 LTE (i.e. conv/org; more tillage levels, more fertilization levels)
- Preferably more than 5 years ongoing
- LTE preferably in a case study region
- Factorial experiment
- Preferably data available from WP3.2

Also the suitability of LTEs and treatments for assessment of biological soil indicators under task 3.4 was taken into account. We decided to focus on two management factors, namely tillage and fertilization treatments, and to include only arable cropping and permanent crops. A sub-selection of these LTEs and their treatments is used for assessments of novel (biological) indicators in Task 3.4.

Table 8. Selection of LTEs and treatments for the 2016 sampling campaign in European LTEs

	Name	Abbrev.	Treatments (total no.)
1	CH-Frick Tillage trial	CH1	conventional vs. non inversion tillage (2)
2	CH-Tillage trial Aesch	CH2	conventional vs. non inversion tillage (2)
3	CH-DOK trial	CH3	System: MIN/DYN (2)
4	NL-BASIS	NL1	ORGANIC system: conventional tillage and minimum tillage; 2 fertilization level: - cut and carry fertilizer and +cut and carry fertilizer (4)
5	NL-Soil quality on sandy soils (de Peel)	NL2	Conventional vs. non-inversion tillage Integrated vs. conventional fertilization (4)
6	SI-Tillorg	SI1	NPK vs. biowaste conventional vs. non inversion tillage (4)
7	PT-VITICHAR	PT1	Biochar, biochar+compost, no amendment (3)
8	ES-TEULARET (only for task 3.3)	ES1	Three tillage treatments (3)
9	ES-PAGO	ES4	Combination of tillage and fertilization (3)
10	HU-Organic/inorganic N fertilization (Keszthely)	HU1	Organic vs. inorganic N fertilization vs. straw incorporation at two N levels (6)
11	HU-Tillage in maize-wheat bi-culture (Keszthely)	HU4	one fertilization level (high NPK) conventional vs. minimum tillage (2)

Laboratory analysis of soil quality indicators

For the sampling campaign, a protocol was made for the sampling method, timing of sampling, coding and storage of samples and the transport of the samples to the central lab. This uniform protocol has been used by the trial owners.

For the assessment of the indicators mentioned in Table 6, two labs were selected based on the best price to quality ratio. The lab selected for the chemical and physical indicators was the soil lab of the Biotechnical faculty, Agronomy department of University of Ljubljana in Slovenia. For the soil biological indicators, the soil lab of the university of Trier was selected. Together with the labs, the protocols for the lab analyses were established. All samples were gathered between early spring and early summer 2016 and have been sent to the central labs for analysis.

All samples have been analysed, results have been gathered centrally and have been sent back to the trial owners for a validity check on the results. After this validity check, the results will be statistically analysed per LTE and over all LTEs. Start of the statistical analysis will be December 2016. A protocol for the total data analysis will be presented and discussed with the total WP3 team.

On-site indicators

Several indicators cannot be assessed centrally, but have to be measured on site (including yield). Clear and uniform protocols were developed to assess the indicators mentioned in table 7. For the on-site soil assessments the protocols were for an important part based on the available protocols of the Core Organic project FertilCrop. For the yield assessments, the protocols were partly based on the protocols developed in the Core Organic project Tilman.

Templates for the soil and yield assessments were developed so the basic data could be collected and assembled in a uniform way. A large part of the yield data have been received before the end of November 2016 and the rest is due in December 2016. After all data have been collected they will be analysed together with the soil indicators assessed in the central labs. Start of the statistical analysis will be December 2017. A protocol for the total data analysis will be presented and discussed with the total WP3 team.

First results

First results are available from the MSc thesis evaluating aggregate stability and particulate organic carbon with respect to their sensitivity to changes in tillage and fertilization practices (Figure 12). For example, the overall effect of tillage on aggregate stability was significant, with an average sensitivity index of about 1.3, which was mainly due to the LTEs from Slovenia and Spain. Particulate organic matter had a positive sensitivity index in the first soil layer of most LTEs, but a negative sensitivity index in the second soil layer of most LTEs.

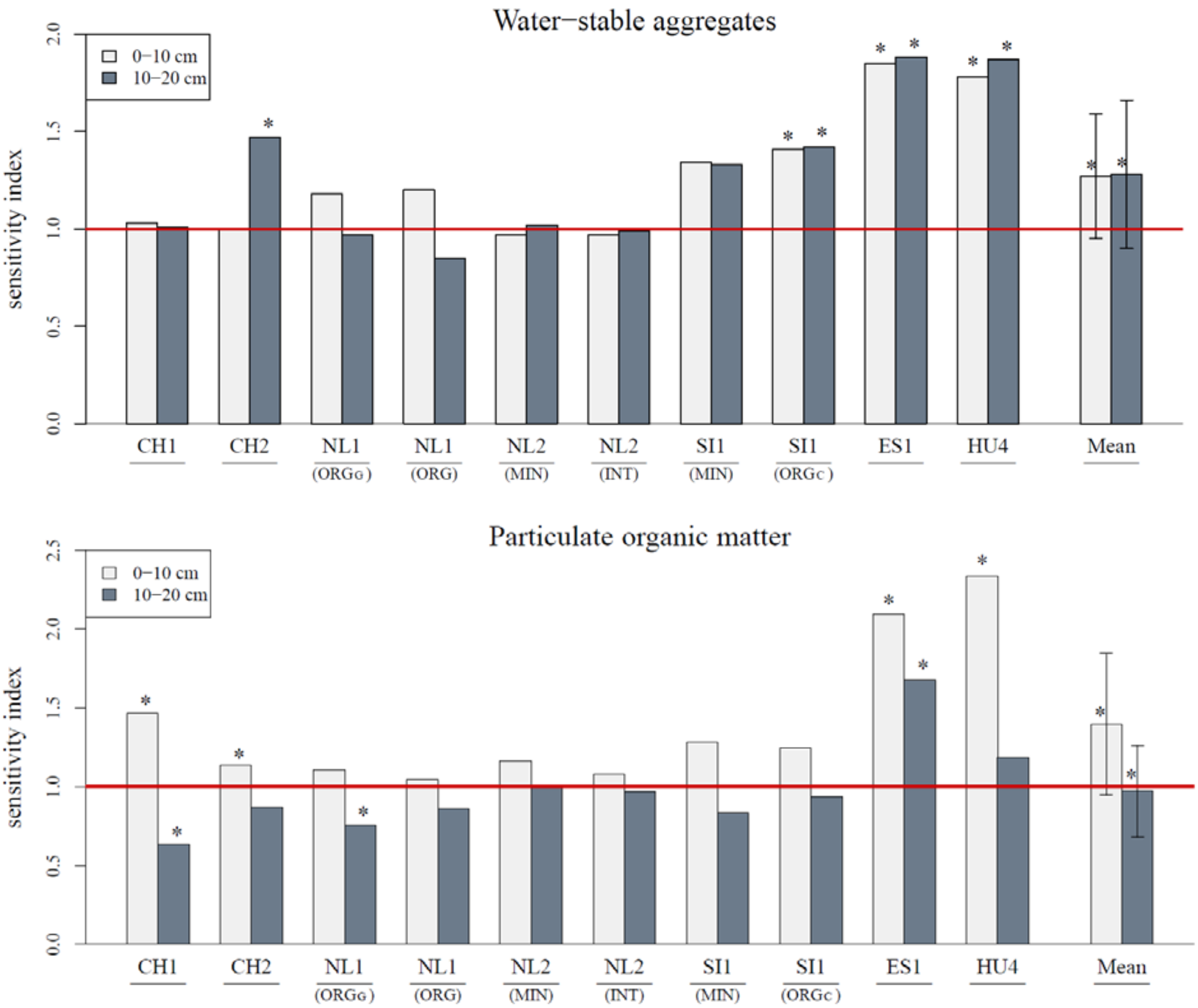

Figure 12. Sensitivity of aggregate stability and particulate organic matter to reduced tillage. Bars show the ratio of each indicator under reduced compared to conventional tillage, with no change in the respective indicator indicated by the red line (sensitivity index = 1). Error bars indicate the standard deviation of the sensitivity index across all LTEs, and stars indicate significant differences between reduced and conventional tillage according to a t-test (p<0.05).

Task 3.4: Screening and evaluation of newly developed indicators of soil quality in long-term trials (Lead partner: FiBL, partners: WU, UE, DLO, IARRP)

Task description

The field of soil quality indicators is rapidly developing and there is a need to improve the capacity and methods for assessing soil-management interactions and their impact on soil functions. Newly developed state-of-the-art soil biological, chemical and physical methods will be evaluated using soils from the long-term field trials.

Technologies for characterization of soil biodiversity and functions are rapidly developing particularly relating to microbial community structure analysis, bar-coding of soil fauna, e-DNA (i.e. environmental DNA derived from biological trace materials), functional genes of the N cycle and "soil fatigue", as apparent from, e.g., the ongoing EU- EcoFINDERS project. Depending on results in TASK 3.1-3.3, a battery of newly developed methods to assess soil biotic community structure, using molecular and functional methods, will be used. At the molecular level, amplicons sequencing of fungal communities including mycorrhiza (ITS region) and of bacterial communities (16S region) by NGS (next generation sequencing) are candidate methods. In the glasshouse we will conduct new functional tests to assess soil fatigue, a phenomenon which is mostly related to an increasing incidence of soil-borne pathogens or to pests due to monoculture or short crop rotations.

In addition to standard soil physical and chemical indicators, which will be part and parcel of the proposed research, modern methods, such as NIRS (near infrared spectroscopy for topsoil organic matter and clay mineral assessment), HWC (hot-water extractable carbon for estimation of mineralizable nutrients) and resin methods for assessment of "available" soil nutrients will be evaluated. The focus will be, however, on enhancing biological soil quality assessment in the search for cost-effective indicators that respond more quickly and predictably to environmental and management stress as well as to soil remediation measures.

Because it is well known that arbuscular mycorrhizal fungi (AMF) play key roles for plant growth and nutrient supply to the plants, we will in addition evaluate methods to assess their presence and functioning.

Activities and results

During the first six months after the start of this task in November 2015, Giulia Bongiorno conducted a literature review on soil quality indicators which was the basis for the development of the project proposal required from the PE&RC graduate school. In the proposal submitted in April 2015, a set of novel biological soil quality indicators to be examined was selected.

At the same time, the long term field experiments (LTE) used for the screening of novel soil quality indicators and of MDS parameters (WP 3.3) were selected (Figure 13). These LTEs were selected based on an optimal combination of agricultural treatments, geographic position within Europe (climate), and soil type, as well as a sound experimental setup.

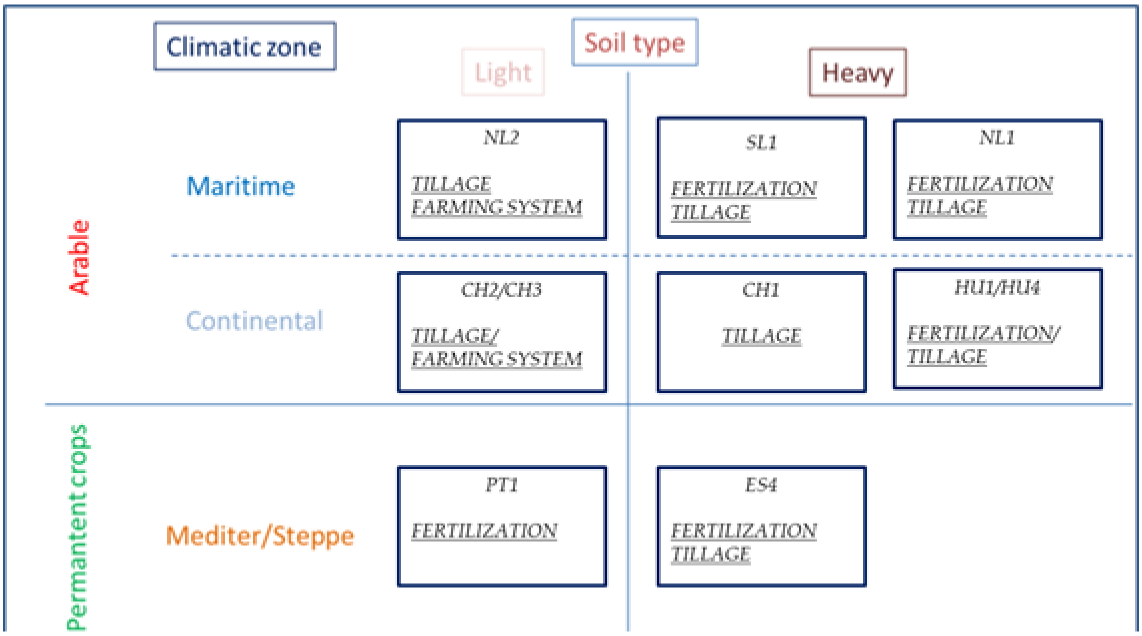

Figure 13. Selected LTEs for the PhD project. The LTEs are arranged according to land use (arable and permanent crops), climatic zone (maritime, continental and Mediterranean / Steppe), and soil type (light and heavy soils). NL1= The Nederlands-BASIS; NL2= The Nederlands-Soil quality on sandy soils (de Peel); CH1= Switzerland - Frick Tillage trial; CH2= Switzerland - Tillage trial Aesch; CH3= Switzerland - DOK trial; SL1= Slovenia - TILLORG; HU1= Hungary - Organic/inorganic fertilization (Keszthely); HU4 = Hungary - Tillage in maize-wheat bi-culture (Keszthely); PT= Portugal - VITICHAR; ES4= Spain - PAGO.

The main objective of task 3.4 is **to assess the suitability of a range of soil biological parameters** as indicators for a selection of soil functions and ecosystem services in European agro-ecosystems. In particular, the effect of agricultural management, i.e. tillage practices and fertilization treatments, on soil parameters will be assessed. Moreover, we will establish relationships between soil parameters and soil functions, namely *nutrient cycling, soil aggregation, humification and decomposition,* and *population regulation*.

The **set of novel biological soil quality indicators which were selected** includes:

a. Characterisation of labile, i.e. biologically active, soil organic carbon by determining:
    i. DOC concentration and quality.
    ii. Permanganate extractable carbon.
    iii. Hot water extractable carbon.
b. Characterisation of soil biodiversity based on DNA analyses:
    i. Analysis of the free-living **nematode community structure and composition.**
    ii. Analysis of the **fungal community** (including mycorrhizal fungi) **structure and diversity.**
c. Community level physiological profiling of the microbial community (MicroResp®).
d. Soil suppressiveness tests with a model system of *Pythium ultimum* and cress**.**

The novel soil quality indicators are being measured in the LTEs shown in Figure 14 on the samples collected in spring 2016. So far, the following measurements have been completed, are in progress or still need to be started:

- Completed: a(i), a(ii), a(iii)
- In progress:
  b(i): total number of nematodes are determined, taxa composition will be analysed in 2017.
  c: first measurements have started in November 2016 and will be completed in 2017.

d: preliminary tests are completed, final tests are foreseen in 2017.

- Not yet started:
  b(ii): these measurements are foreseen to begin the end of 2017.

The results of the labile carbon analysis (DOC and Hy concentration, DOC SUVA, Hy SUVA, POXC, and HWEC) are in the process of being analysed. For each site, a Sensitivity Index is calculated as mean value of the alternative practice divided by the mean value of the conventional practice (e.g. mean value of reduced tillage in the LTE CH2/ mean value of conventional tillage in the LTE CH2). In Figure 14, the Sensitivity Index of the DOC concentration (mg/l) is shown.

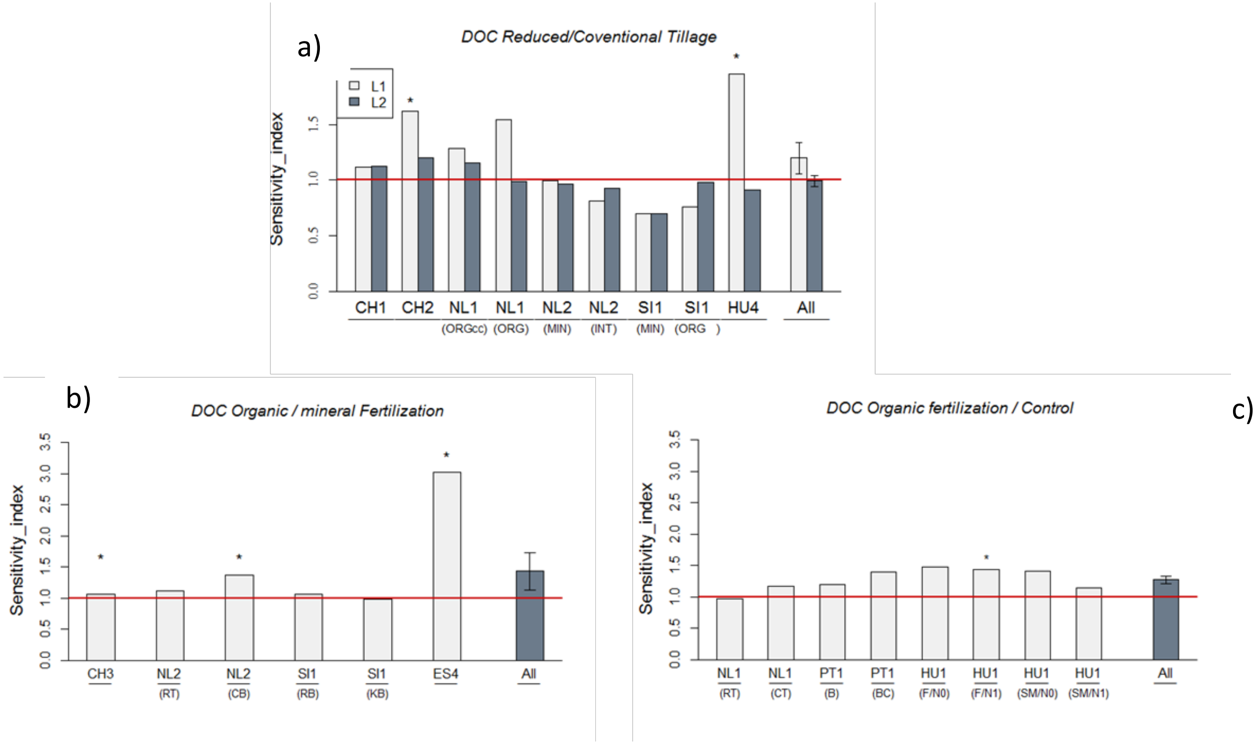

Figure 14. Bar plots showing the Sensitivity index for the DOC concentration expressed in mg/l. a) trials with reduced and conventional tillage, with the Index calculated for each soil layer separately; b) trials comparing organic and mineral fertilization; Index calculated for the first layer only. c) trials comparing organic fertilization and unfertilized control; Index calculated for the first layer only. Asterisks indicate significant (p<0.05) results of the t-test for the comparison of the two managements.

1.2.4 Work Package 4

Summary

The development of a soil quality assessment tool is the central focus of the project. The tool will be developed in the format of an IT app – Soil Quality app (SQAPP) – running on mobile and/or notepad devices to facilitate in-field data collection. The app will be designed such that it can either be used stand-alone or allow connection with a server in the cloud where an extensive database will inform the SQAPP user immediately about the state of soil quality and recommended measures for improvement (these recommendations will follow from analysis in WP6). The app will accommodate operation at different levels of complexity, starting off with a minimum data set of easily observable/measurable indicators (WP3) which can be extended when more detailed data are available. At the same time, data submitted to the server can be used to inform aggregate soil quality monitoring. However, the user will be in control regarding data sharing. Some web-based functionality may only be available to users sharing data, e.g. regional reference values may depend on user contributions and as such could be regarded as premium content for those who do. This WP internalises all activities directly geared towards development of the app, while strong linkages to other WPs will ensure iterative improvements to the app.

Specific objectives are:
1. Lay out the specifications of SQAPP design and functionality at different levels of complexity (Task 4.1);
2. Develop a first release of SQAPP (Task 4.2);
3. Analyse first release performance and upgrading of SQAPP (Task 4.3);
4. Rolling out Beta-release and web-based data platform across Europe and China (Task 4.4);
5. Release of final SQAPP based on feedback of users of Beta-version and expert judgement (Task 4.5).

App development is the core of the second stage of the project. So far, the focus has been on conceptual development (Task 4.1), with technical work to start in the next reporting period.

Task 4.1: Specifications of SQAPP design and functionality at different levels of complexity (Lead partner: WU, partners: UNIBE, MEDES, ISRIC, DLO, ICPAC, ESAC, IARRP, UP, ISS)

Task description

This task entails intensive collaboration between researchers, intended end-users and software developers to define, from the outset, what the most important functionalities are for the soil quality assessment app at different levels of complexity, so as to outline how the app and underlying database architecture should be structured. The idea is here to lay out a full palette of possible functionalities and options to accommodate any demand for development or later extension of the app as end-user needs or technological capabilities increase, allowing for use with a minimum set of easily observable indicators as well as more complex operation if more detailed data is available. This task will for a major part run simultaneously with Task 4.2 to ensure the functionalities can accommodate the requirements from the content-side. Activities to complete this task successfully will comprise a review of existing (partial) apps, evaluation of existing tools with both developers and end-users of those tools, defining technical specifications of hardware, and assessment of costs versus functionality.

Activities and results

Work on Task 4.1 commenced in month 12 according to plan, and has so far focussed on conceptual development of the SQAPP. Important input from WP2 and WP3 gradually became available to support concept formulation. Conversations with farmers, software developers, and researchers have simultaneously helped shaped ideas. Different sessions were organized to discuss and present the SQAPP concept (at the Hungary plenary meeting, at LandMark session at the European Ecosystem Services conference Antwerp, and the Global Land Project Open Science Meeting and IARRP Seminar, both in Beijing). Figure 15 presents the current ideas. The app should cater for different levels of complexity, and with variable level of user input. It starts with giving the user information about the pedo-climatic zone and farming system in which (s)he is located, using a GPS location or entered location. Soils in pedo-climatic zones may still have a wide variety of properties, but with simple additional user observations (e.g. soil colour, texture, position in the landscape) a more precise estimate of soil type and soil quality indicators can be generated. Similarly with a specific farming system, further details on land use can help give a more precise idea of the soil quality indicators expected for the reported conditions. Without more precise information about land management, a probability density function of each soil quality indicator can be shown. After characterising land management practices, a soil quality score may be projected on the probability curve. The user could proceed based on these projections, or replace the projected scores with measured or observed values (e.g. from soil chemical analyses). By recording and revisiting scores from time to time, a change record can be kept, to assess whether soil quality is improving or decreasing as a result of management practices. After comparing indicator scores to benchmarks, recommendations can also be given to agricultural management practices likely to improve soil quality (or that have proven successful in similar conditions). Eventually, the SQAPP may also allow reporting and exchanging experiences to create interactions between app users.

Figure 15. Conceptual overview of the Soil Quality App (SQAPP). From left to right going from placing the (field) location in context (pedo-climatic zones and farming systems) to detailing local soil information (link SoilGrids), land use and management, to generating probability density functions of soil quality information, monitoring soil quality information over time, acquiring management advice (link WOCAT) and sharing experiences about agricultural management practices.

Task 4.2: Developing of first release of SQAPP (Lead partner: WU, partners: JRC, ISRIC, UP, ISS)

Task description

Based on the performance of soil quality indicators in existing indicator systems (WP3) and experience with such systems in specific combinations of farming systems and pedo-climatic zones (WP2) we will identify the most promising indicators to be included in SQAPP. Farming systems and pedo-climatic zones are likely to have a large impact on the usefulness of specific indicators, such that a modular approach is envisaged. The pilot app (D4.1) will consist of a minimum data set to be applied universally, with modular add-on functionalities based on location (linked to pedo-climatic conditions and land use). With the data collected in WP2 and WP3, a first release of the app will be produced that will subsequently be tested in the field with stakeholders (WP5). When compiling and connecting the various indicators, information gaps will be identified that will be fed back to WP3 for further exploration.

Activities and results

Task not yet active.

Task 4.3: Analysis of first release performance and upgrading of SQAPP (Lead partner: WU, partners: FiBL, UNIBE, MEDES, ISRIC, DLO, ICPA, ESAC, UMH, IARRP, UP, ISS)

Task description

In this task results and feedback from the application of the first release of the app in WP5 will be analysed to assess the performance of, and user experience with the app. Information from different land users in case study areas will be used to improve the pilot app; the field application of the app is likely to confront it with a range (combinations) of conditions which needs to be analysed for a) indicator ranges for which the app has been designed; b) correlations between multiple indicator scores; and c) consistency of soil quality assessment and recommendations across farming systems and pedo-climatic zones. This activity will also be aided by availability of analysis from long-term field trials (WP3). In addition, under this task we will be able to define local benchmarks for different combinations of farming systems and pedo-climatic zones, such that soil quality indicator scores are contextualised for the range of local conditions and best possible scores can be set as reference levels. This analysis, which will be adapted to relevant scale depending on data availability, will be integrated into the development of a Beta-release of the app for broad testing (Task 4.4).

Activities and results

Task not yet active.

Task 4.4: Rolling out Beta-release and web-based data platform across Europe and China (Lead partner: WU, partners: JRC, ISRIC, ISS)

Task description

Given the experience with the first release of SQAPP (Task 4.2) and upgrading and further contextualising of the app in Task 4.3, in this task we will roll out a Beta-release and web-based platform of the app across Europe and China. This will allow widespread testing of the app beyond the partners in the immediate consortium, offering the potential to truly test the app across a pan-European and pan-Chinese range of conditions. This version of SQAPP will also be employed in on-farm experiments to test the usefulness of the tool to monitor soil quality improvement (WP6). Apart from developing the app and promoting it (in WP9), this task will also design a web-based data platform to systematically process experiences and feedback from users willing to share data and feedback centrally. The rolling out of the Beta-release and web-based data platform will be an important Milestone of the project and will allow extensive testing of the system to feed into the development of the final version of the app (Task 4.5).

Activities and results

Task not yet active.

Task 4.5: Release of final SQAPP based on feedback of users of Beta-version and expert judgement (Lead partner: WU, partners: JRC, FiBL, UNIBE, MEDES, ISRIC, DLO, ICPA, ESAC, UMH, IARRP, UP, ISS)

Task description

In this final task we will refine the soil quality assessment app by addressing the main issues experienced by test users of the Beta release. Simultaneously, final results from WP5/6 will allow further improvement of the decision structure of which indicators need to be assessed under what conditions, the consistency of combining various indicators, and connecting the current soil quality with management recommendations. This task entails a combination of technical tweaks and system analyses as well as expert judgement – the latter primarily regarding the type and sequence of management interventions for different farming systems across Europe and China, with varying level of detail reflecting the user input received. The task will also provide a link to WP7 to develop monitoring of soil quality at the continental scale. The final deliverable of the task and the WP as a whole is a tested and validated final version of SQAPP (D4.2). Within the context of the project, no commercialization activities of the developed app will be deployed.

Activities and results

Task not yet active.

1.2.5 Work Package 5

Summary

WP5 links applied agricultural management practices to the soil quality status in the Case Study Sites and selects innovative practices together with stakeholders. Associating changes in soil quality with agricultural management practices is a challenge due to slow responsiveness of soil characteristics, and can therefore only be approximated by comparing different management practices applied under identical pedo-climatic conditions. The generation of a soil quality inventory at the Case Study Site level will provide the framework to test the alpha-release version of the SQAPP. The testing is carried out in collaboration with multiple actors, such as farmers, agricultural advisors, local staff of government and research institutions and soil specialists. With the help of these actors, currently applied and promising agricultural management practices are identified, documented and assessed holistically (i.e. regarding their economic, ecological and socio-cultural impact). This assessment provides the criteria to select innovative practices, or the basis to develop new ideas for management improvements respectively. The WP follows a trans-disciplinary as well as interdisciplinary approach in order to include the broadest expertise and perception of soil quality and agricultural management practices as possible, and to make sure the SQAPP will be truly relevant for application in practice.

The main objective of WP5 is to link applied agricultural management practices to the soil quality status in the Case Study Sites, and select innovative practices together with stakeholders.

Specific objectives are:
1. To apply and test the soil quality assessment tool with a variety of actors (Task 5.1);
2. To make an inventory of soil quality status and applied agricultural management practices at the Case Study Sites (Task 5.2);
3. To select innovative agricultural management practices improving soil quality (Task 5.3);

A summary of the Deliverables and Milestones planned within our activities is presented in Table 9. The third column gives the deadlines of these activities. Accomplished work is given in the shaded rows.

Table 9. Description of the tasks to carry out during the project-time life and their corresponding deliverable time; accomplished work is given in the shaded rows.

		Description	Month
Deliverables	D5.1	Report on stakeholder feedback to soil quality assessment tool	32
	D5.2	Soil quality inventory of Case Study Sites	38
	D5.3	Database of currently applied and promising agricultural management practices	48
Milestones	M5.1	Actors to be included in Case Study Sites identified	10
	M5.2	Selection of innovative agricultural management practices to be evaluated in WP6	24
	M5.3	Stakeholder feedback ready for SQAPP improvement	28

The main achievements of WP5 during reporting period 1 were the stakeholder identification as part of Task 5.1 and the first soil quality and agricultural management practices inventory as part of Task 5.2. The stakeholder inventory, following a simple snowball method with a short questionnaire, revealed a long list of stakeholders across all sites with a variety of background, roles and aims. This fist contacts to the stakeholders and a close collaboration with WP6 allowed to provide a sound basis for the selection of innovative agricultural management practices to be tested in the case study sites. A list of agreed agricultural development practices, considered relevant regarding soil quality improvements, was provided to the case study partners together with a manual on how to assess soil quality with and without these practices. All the case study partners have successfully applied a first assessment with these tools, which shall be repeated next autumn again. Training on WOCAT methods on how to document and evaluate the identified agricultural management practices was also provided.

Task 5.1: Multi-stakeholder testing of the soil quality assessment tool **(Lead partner: UNIBE, partners: WU, UPM, MEDES, CorePage, Case Study Site partners)**

Task description
In order to test the SQAPP developed in WP4, the tool will be applied by multiple stakeholders on farmers' fields within the Case Study Sites. Relevant stakeholders will be specified for each Case Study Sites at the beginning of the project. The testing will be done in a systematic way, using standardized protocols to identify data quality as well as benefits and disadvantages of different aspects and features of the tool. WP5 will also facilitate the capturing of ideas for tool enhancement from a variety of potential users and other stakeholders, such as within multi-stakeholder workshops at the case study sites (see Task 5.3). The testing of the SQAPP will be an iterative and repeated process throughout the tool development phase.

Activities and results

Milestone M5.1 *Actors to be included in Case Study Sites identified* is the main result of task 5.1

At the beginning of the project it was important to find the stakeholders that are relevant for the project, who can contribute to the app development with their insights and / or for soil quality improvement, and who are willing and able to cooperate with the project. For the identification of these relevant stakeholders in the iSQAPER case study sites, a questionnaire was developed and sent to the case study partners together with detailed instructions. The questionnaire was then translated into the local languages. To identify stakeholders and communicate about the iSQAPER project, the questionnaire was used together with the project leaflet, which was also available in the local languages.

The stakeholder identification helped to figure out who the stakeholders are, what their stake is in the research and which relevant stakeholders may still be missing. Which stakeholders were chosen depended on their potential involvement in the project concerning the type of area, topic, role, sector and aim they have. With this information about the stakeholders the case study partners were able to see if the stakeholders together cover the spectrum that was needed for the iSQAPER project. If issues were clearly missing, additional stakeholder were approached until a certain diversity among them was reached.

The stakeholder inventory was conducted using a snowball sampling approach adapted to the project situation from a similar initiative conducted in the EU-RECARE project (http://www.recare-hub.eu/; Leventon et al 2016). In this approach, a first set of stakeholders known to the case study partners fill in a questionnaire and identify several other stakeholders each. This “secondary” set of stakeholders is interviewed and, in turn, each interviewee identifies further stakeholders. This loop is repeated until the overlap between already interviewed stakeholders and new suggestions increases significantly, or until the case study partner considers the variety of stakeholders as sufficient.

Milestone M5.1 is the compilation of the stakeholder inventory. This milestone shows per case study site, 14 in total, the numbers and types of stakeholders approached by the research teams of iSQAPER. Their number varies from 2 to 53, in total 234 stakeholders for iSQAPER were identified (Table 10). The size from the institutes represented by the stakeholders differ from 1 person (about 30 stakeholders) to more than 50 per stakeholder. Many of the Chinese stakeholders are from agricultural institutes or villages that work with cooperatives representing more than 50 persons per stakeholder. That multiplies the number of stakeholders that are (in)directly related to iSQAPER. The respondents of the questions were 35 women and 169 men, 30 are not known because they were answered by families or not filled this question. See also the overview below.

The areas covered by the stakeholders differ from local (half of the stakeholders) to international (about 30 stakeholders). About roles: Half of the stakeholders are land workers, who at the same time can be the manager or the owner of the land, taking the decisions on the land use, methods and approaches. There are also many information providers for farmers as well as for the public involved in the project. The private sector is more represented among the stakeholders than the public sector like government or NGO or the academic representations. This is mainly because of the many involved farmers.

The topics that interest the stakeholders are for half of them the “soil quality”. Also “environmental protection and conservation” and “sustainable land management” score high in the topics. The stakeholder cover all the mentioned farming systems whereas “arable lands” and “permanent crops” are most mentioned, followed by “open field vegetables” and “grazing intensive”. Concerning the soil improvement practices the issues like “no-till”, residue maintenance” and “diversified crop rotation” are often mentioned.

Table 10. Stakeholder Identification at Case Study Sites

iSQAPER Study site stakeholder identification	**Total**	**2.3 Role**	**Total**
1.1. men /	169	Land owner	71
Women	35	Land manager	49
total SH (incl. family, not answered etc.)	**234**	Land worker	119
1.3. size SH a = 1 person	31	Consumer of products	105
b = 2-10 persons	62	Consumer of services (recreation, etc.)	3
c = 11-50 etc.	35	Provider of information to the public	44
d = 50 >	105	Provider of information/advice to land managers/workers	50
2.1. area SH Local	136	Regulation and enforcement	13
Municipal	18	Equipment and/or tool provision	4
Regional	43	Creating market opportunities for products	4
District	5	Retailer of products	13
other (i.e. National, European)	32	Providing finance to land managers/owners/workers	15
2.2.Topics::	33	Community leader	4
Farming system: Grazing intensive	35	Constructor (infrastructure and/or buildings)	1
Grazing Extensive	17	Product certification (organic farmer)	18
Arable land	89	Other, Specify non-organic Farmer+ Certification:	3
Open-field vegetables	40	other, non-organic farmer	23
Permanent Crops	74	other, technician	2
Other	6	other, manager, research institute	1
Community development	10	other, vice president soil society	1
Education	34	other, researcher	3
Environmental protection and conservation	47	other, nature conservator	1
Forestry	9	**2.4. Sector**	1
Land use policy and planning	24	Private Sect: other, landowners, farmers	63
Product exploitation	22	Academic	36
Recreation	3	Government	31
Research and development	35	Private individual	62
Soil quality	92	Private Sector: industry	13
Soil improvement practices:	20	Private Sector: retail	16
cover crops,	36	NGO	7
no-till,	40	Public enterprise	7
min-till,	39	Other, Specify public organization	5
buffer strips,	8	Civil Society	3
contour tillage/planting,	11	Other, citizen	3
residue maintenance	58	Other, private association	1
permanent soil cover,	17	**2.7. Most asked info**	
diversified crop rotation,	47	Information about soil	118
leguminous crops,	41	soil (quality) improvement practices	101
other	15	comparator data, explanation of the data	18
Sustainable land management	50	soil quality (how to improve/assess/estimate)	14
Water management	24	Fertilization/fertilizer/irrigation	17

The “aim” is often about better understanding of the soil and its management. Many also mention the cooperation with the partners in the project and several mention the use of the app as their aim as a stakeholder in iSQAPER.

The “information they use” about soil is often own knowledge, climatic conditions and they often monitor the physical, chemical and biological condition of the soil, water quality and many other inventive and interesting measurements are being mentioned.

The “information that they want to know from the project” is mostly about soil improvement practices. All with the intention to know how the project can serve the stakeholders and vice versa to develop the best app in support of sustainable soil quality.

This list of stakeholders identified in this Milestone (Table 10) was later expanded to additional stakeholders dealing with innovative Agricultural Management Practices in order to cover the needs of Milestone M5.2 as described below.

Reference:
Leventon J, Fleskens L, Claringbould H, Schwilch G, Hessel R. 2016. An Applied Methodology for Stakeholder Identification in Transdisciplinary Research. Sustainability Science. DOI: 10.1007/s11625-016-0385-1

***Task 5.2: Soil quality and agricultural management practices inventory at case study sites* (Lead partner: UNIBE, partners: JRC, UE, ISS, Case Study Site partners)**

Task description

While testing SQAPP at the case study sites, an inventory of the current status of soil quality can be compiled. This inventory will be done across a representative number of fields across the main pedo-climatic zones apparent in the Case Study Site. Additionally, comparing the soil quality status with farmers’ interviews about their historical changes in management will help to identify those management practices which have improved soil quality. Whether the latter is indeed the case will thus be assessed based on stakeholder observation and perception of changes. Comparison of soil quality status under different agricultural management practices within the same pedo-climatic zone will help to derive those practices which have a relevant impact on soil quality.

Promising land management practises thus result from identifying those practices, which are applied on healthy soil or have improved the soil quality status markedly. Using the standardized WOCAT framework for documentation and evaluation of Sustainable Land Management (SLM) technologies (see www.wocat.net/en/methods/slm-technologies-approaches.html), 3-5 of these practices per study site are recorded. The framework enables to describe the details of the land management practices, including costs of implementation and maintenance, and provides a comprehensive list of economic, ecological and socio-cultural benefits and disadvantages, including off-site impacts.

Activities and results

For the soil quality and agricultural management practices inventory at case study sites a manual was developed in order to standardize and facilitate the task. The manual gives a clear and precise description on how to assess the indicators of soil quality based on Visual Soil

Assessment Methodology (VSA). On the basis of a thorough analysis of the literature review in the topic, 11 indicators were selected.

In order to compare soil quality status under different Agricultural Management Practices (AMPs), these AMPs first had to be identified. This was an essential prerequisite for Task 6.1 of WP6 consisting of the selection of sites for testing, evaluating and demonstrating selected ‘soil improving’ measures. On the basis of a literature review, potential AMPs mentioned by the case study sites, and comparable practices documented within the WOCAT database, a list of 19 innovative AMPs was established (Table 11).

The questionnaire was presented and discussed with all project partners during the plenary meeting in Hungary, 20-24 June 2016. In addition, a training in the field presenting selected VSA methods was carried out during the field day of the meeting (Figure 16).

Figure 16. Explaining soil quality assessment methods to case study partners

On the basis of useful comments and feedbacks, an improved version of the manual was then established. It contains a detailed monitoring plan including a list of indicators to use, description of their assessment, related scoring and additional references (see Figure 17).

The main aim of this inventory is to link applied agricultural management practices (AMP) to the soil quality status at the case study sites, and to identify innovative practices that have improved soil quality (SQ). This inventory should be completed together with the stakeholder in situ. Scoring should be done with the consent of the stakeholder as well. The inventory is to be done across a representative number of fields across the main pedo-climatic zones apparent in the Case Study Site. It is proposed to compare the soil quality of a farm where changes have occurred at least 3 years ago with another farm without changes in AMP within the same pedo-climatic zone and under comparable soil conditions, topography, etc., serving as control. The case study partners were requested to identify at least 3 different AMPs (or combinations) and 3 related controls.

The main challenge of this work was to address different threats over Europe and China. However, the aim was to include the broadest expertise and perception of soil quality and agricultural management practices as possible. This will help to implement innovative AMPs based on the criteria of improving soil quality for comparable pedo-climatic zones considered in the project and covering all study sites across Europe and China.

The questionnaire was finally adopted and successfully applied by all Study Site partners and the first results are currently under analysis. This exercise serves as a test for further improvements and will be repeated in the next few years. This will finally provide sound data on soil quality status and its improvement through AMPs across Europe.

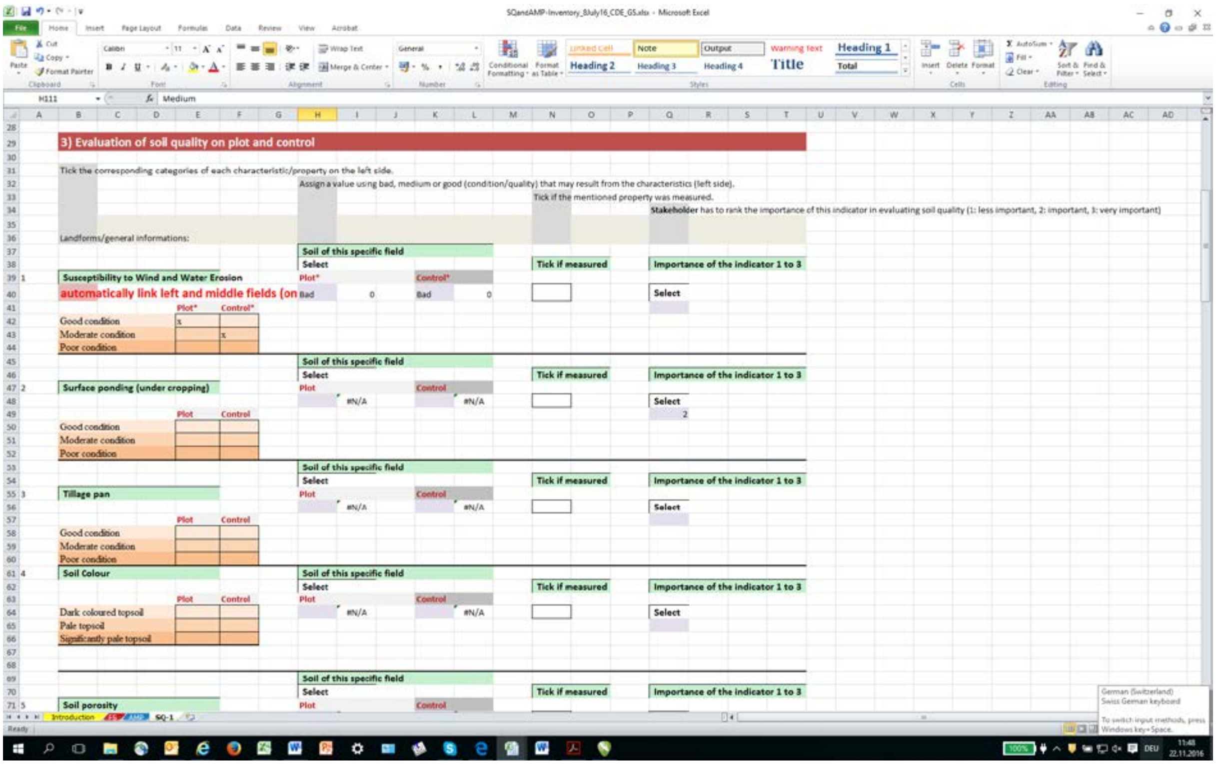

Figure 17. Excel questionnaire developed to assess the impact of innovative AMPs on soil quality; the evaluation of soil quality is scored from 0 (bad condition) to 2 (good condition).

Table 11. List of innovative AMPs with detailed description and expected impacts and ecological benefits.

Category	**AMP measures**	**Description**	**Expected impacts / Ecological benefits**
Soil management	No-till	A system where crops are planted into the soil without primary tillage	Reduces decomposition of OM rates leading to its increase in soil, enhances cycling of nutrients, enhances soil structure and increases water infiltration. Improves soil biological life including disease and weed

			suppression.
Soil management	Min-till	Tillage operation with • reduced tillage depth • strip tillage • mulch tillage or a combination thereof	Reduces decomposition of OM rates leading to its increase in soil, enhances cycling of nutrients, enhances soil structure and increases water infiltration. Improves soil biological life including disease and weed suppression.
Crop rotation/Soil management	Permanent soil cover / Removing less vegetation cover	Avoiding a bare or sparsely covered soil exposed to weather conditions (rain, wind, radiation, etc) by ensuring a permanent cover (at least 30% of the soil surface) throughout the year, e.g. through cutting less grass, leaving a volunteer crop or crop residues, etc. (*see also cover crops and residue maintenance / mulching*)	• Improves infiltration and retention of soil moisture resulting in less severe, less prolonged crop water stress and increases availability of plant nutrients. • Provides source of food and habitat for diverse soil life: created channels for air and water, biological tillage and substrate for biological activity through the recycling of organic matter and plant nutrients. • Increases humus formation. • Reduces the impact of rain drops on soil surface resulting in reduced crusting and surface sealing. • Reduces runoff and erosion. • Reduces wind erosion. • Increases soil regeneration. • Mitigates temperature variations on and in the soil. • Improves the conditions for the development of roots and seedling growth.
Nutrient management	Cover crops	a. Cover cropping: planting close-growing crops (usually annual legumes), b. Relay cropping**:** specific form of mixed cropping / intercropping in which a second crop is planted into an established stand of a main crop. The second crop develops fully after the main crop is harvested. c. Better crop cover: selecting crops with higher ground cover, increasing plant density, etc.	a. Protects soil, between perennials or in the period between seasons for annual crops. N-fixation in case of leguminous crops. b. Continuously covered soil. Reduces the insect/mite pest populations because of the diversity of the crops grown. Reduces the plant diseases. Reduces hillside erosion and protected topsoil, especially the contour strip cropping. Attracts more beneficial insects, especially when flowering crops are included in the cropping system. c. Protects soil against the impacts of raindrops or wind and keeps soil shaded; and

			increases moisture content.
Nutrient management	Leguminous crop	A leguminous crop is a plant in the family Fabaceae (or Leguminosae) that is grown agriculturally, primarily for their grain seed called pulse, for livestock forage and silage, and as soil-enhancing green manure. Well-known legumes include alfalfa, clover, peas, beans, lentils, lupins, mesquite, carob, soybeans, peanuts, and tamarind.	Provides soil with nitrogen and additional nitrogen from chemical fertilizers is not necessary. *(See also cover crop and green manure)*
Nutrient management	Green manure / Integrated soil fertility management	Green manure is a crop grown to be incorporated into the ground, while the more general term 'integrated soil fertility management' refers to a mix of organic and inorganic materials, used with close attention to context-specific timing and placing of the inputs in order to maximize the agronomic efficiency.	Increases organic matter content, thereby improving fertility and reducing erodibility. In case of leguminous green manure, tilling it back into the soil allows exploiting the high levels of captured atmospheric nitrogen found in the roots.
Nutrient management	Manuring[a] / composting[b]	a) Manure is organic matter, mostly derived from animal feces (except in the case of green manure, which can be used as organic fertilizer in agriculture). b) Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming.	a) Contributes to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are trapped by bacteria in the soil. b) Improves soil fertility through nutrient content and availability, soil structure and microbiological activity; impacts plant growth and health directly and indirectly.
Nutrient management	Residue maintenance / Mulching	Maintaining crops residues or spreading of organic (or other) materials on the soil surface.	• Reduces sheet and rill erosion. • Reduces wind erosion. • Maintains or improves soil organic matter content. • Conserves soil moisture. • Provides food and escapes cover for wildlife.

Crop rotation	Crop rotation[a] / Control or change of species composition[b]	a. Practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown repeatedly on the same field b. Diversify species in rotation systems or grasslands	a. Reduces risk of pest and weed infestations. Improves distribution of channels or biopores created by diverse roots (various forms, sizes and depths). Improved distribution of water and nutrients through the soil profile. Allows exploration for nutrients and water of diverse strata of the soil profile by roots of many different plant species resulting in a greater use of the available nutrients and water. Increases nitrogen fixation through certain plant-soil biota symbionts and improved balance of N/P/K from both organic and mineral sources. Increases humus formation. b. Introduces desired / new species, reduces invasive species, controls burning, residue burning.
Structural management	Cross-slope measure	Structural measure along the contour to break slope lengths, such as terraces, bunds, grass strip, trashlines, contour tillage	Reduces surface runoff and erosion (increase infiltration capacity).
Soil management	Measures against compaction	a) Breaking compacted soil: e.g. deep ripping, subsoiling (hard pans); Digging the soil up to twice as deep as normally. b) Growing deep rooted plants in the rotation such as: annual alfalfa, beet, sunflower, okra, flax, turnip. c) Controlled traffic farming: is a system which confines all machinery loads to the least possible area of permanent traffic lanes d) Soil compaction models (considering tire size, inflation pressure, weather and soil conditions) to predict allowable wheel load and soil compaction maps to show how soil compaction varies at different locations and depths across the field	a-b)Looses soil to improve drainage, infiltration, aeration and rooting characteristics, and brings nutrients up from deep below c-d) Minimizes soil damage and preserves soil function in terms of water infiltration, drainage and greenhouse gas mitigation, and (d) provides useful information for decision making process for site-specific applications such as variable deep tillage to benefit from increased timeliness (and reduced management costs)

Pest management	Integrated pest and disease management incl. organic agriculture	Appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to reduce or minimize risks to human health and the environment.	Emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.
Water management	Water diversion and drainage	A graded channel with a supportive ridge or bank on the lower side. It is constructed across a slope to intercept surface runoff and convey it safely to an outlet or waterway	Reduces hazard towards adverse events (floods, storms,…), reduces soil waterlogging
Water management	Irrigation management	Controlled water supply and drainage: mixed rainfed – irrigated; full irrigation; drip irrigation	Improves water harvesting; increased soil moisture; reduces evaporation; improves excess water drainage; recharge of groundwater
Agricultural management	Major change in timing of activities	Adaptation of the timing of land preparation, planting, cutting of vegetation according weather and climatic conditions, vegetation growth, etc.	Reduced soil compaction, soil loss, improved biomass, increased biomass, increased soil OM
Landscape management	Layout change according to natural and human environment/needs	eg exclusion of natural waterways and hazardous areas, separation of grazing types; increase of landscape diversity.	Reduces surface runoff and erosion, increases biomass, nutrients and soil OM, controls pests and diseases
Landscape management	Area closure / rotational grazing	Complete or temporal stop of use to support restoration	Improves vegetative cover, reduces intensity of use, and soil compaction and erosion.
Landscape management	Change of land use practices / intensity level	eg change from grazing to cutting (for stall feeding), from continuous cropping to managed fallow, from random (open access) to controlled access (grazing land), from herding to fencing, adjusting stocking rates.	Increases biomass, nutrient cycling, soil OM, improves soil cover, beneficial species (predators, earthworms, pollinators), biological pest / disease control, and increases / maintains habitat diversity. Reduces soil loss, soil crusting/sealing, soil compaction, and invasive alien species.

After the identification of innovative AMPs (Milestone M5.2), the second part of Task 5.2 includes the documentation of these using the standardized WOCAT framework. The aim is to **document and evaluate 3-5 of these practices** per case study site with their details, including costs of implementation and maintenance, and economic, ecological and socio-cultural benefits and disadvantages (see www.wocat.net/en/methods/slm-technologies-approaches.html).

During the plenary meeting in Hungary, 20-24 June 2016, a short **WOCAT training** was provided to the case study partners. The aim of this input was to explain the evaluation and documentation of AMPs using WOCAT Technology questionnaire through standardized documentation of experiences. The main components of the WOCAT Questionnaire on Technologies (QT) was presented in detail. The WOCAT questionnaires will be applied by the case study partner in the next reporting period. It requires a team of land management specialists – including land users – with different backgrounds and experience, who are familiar with the details of the AMP (technical, financial, socio-economic). The documented AMPs will then be recorded in the global WOCAT database and thus made publically available.

Task 5.3: Selection of innovative agricultural management practices **(Lead partner: UNIBE, partners: UE, UPM, Case Study Site partners)**

Task description

The global WOCAT database of SLM technologies provides the platform to share experience of agricultural management practices across the case study sites, as well as globally. The selection of innovative agricultural management practices is guided by the documented existing practices across the project study sites and from other comparable sites within the WOCAT database. A search interface for the WOCAT database integrates with the soil quality assessment tool and will facilitate the search. Potential innovations do not only refer to new practices, but equally to variations of existing, well proven practices. In order to identify new or 'improvable' practices, a structured process of joint selection and negotiation within a multi-stakeholder participative workshop is conducted at each case study site. The workshop is designed to provide the creative environment that enables to develop new ideas for management improvements and allows innovations to flourish. The soil quality improvement potential of selected practices will subsequently be tested in WP6.

Activities and results

The resulting list of innovative AMPs established under Task 5.2 (listed in table 9) reflects the range of the most promising innovative AMPs capable of enhancing soil quality and functions and contributing to sustained crop and animal production. On the basis of this list and in combination with the range of farming systems and pedo-climatic zones, the sites for testing, evaluation and demonstration have been established by WP6 (Milestone M6.1).

The accomplished work is a prerequisite basis for the main tasks of the project because of the following main reasons:

- The stakeholders dealing with the innovative AMPs are the relevant stakeholders for testing of the SQAPP (developed in WP4) using standardized protocols for the identification of data quality, benefits and disadvantages of the tool.
- The identification of the AMPs list and the related actors have been used to carry out a first questionnaire for the evaluation of soil quality at the selected case studies necessary for Task 5.2 "Soil quality and agricultural management practices inventory at case study sites" deliverable on Month 38. The main aim of this first questionnaire sent to all Study Site leaders on Month 17 was to check the reliability of the selected indicators in evaluating soil quality.
- Our results will also serve for up-scaling the innovative AMPs and corresponding farming system in Europe and China (Task 7.1, WP7, D7.1).

1.2.6 Work Package 6

Summary

WP6 assesses the impact of innovative management practices on soil quality and crop performance and provide the necessary iterative feedback for the further improvement of SQAPP. This WP selects representative sites where promising measures can be tested for their performance with regard to soil quality and overall sustainability of crop and livestock production. A demonstration component within this WP provides valuable support for both up-scaling activities and for dissemination and communication. Activities include: i) selecting sites for testing, evaluating and demonstrating selected promising 'soil improving' agricultural measures; ii) identifying parameter/indicator sets for testing and evaluating the impact on soil quality and crop production parameters; iii) assessing parameters/indicators (including through applying SQAPP) for testing and evaluation of innovative agricultural management practices; and iv) organizing demonstration events at selected field sites. The main deliverables of this WP will be an internal report on performance of promising agricultural management practices to populate recommendations of SQAPP (TRL5), and a report on the performance of key and site-specific parameters and indicators for all monitored sites (TRL6).

The specific objectives of WP6 to be pursued in different tasks will be to:

1. Select sites for testing, evaluating and demonstrating of selected promising 'soil improving' measures (Task 6.1, MS 6.1, month 18);
2. Identify parameter/indicator set for testing and evaluating the impact on soil quality and crop production parameters (Task 6.2; MS 6.2, month 14);
3. Assess parameters/indicators (including through applying SQAPP) for testing and evaluation of innovative management practices (Task 6.3, D 6.1, month 48);
4. Organize demonstration events at selected field sites (Task 6.2, month 54).

Task 6.1 has started in Month 8 and finished in month 18 as predicted. During this period, the testing sites were selected to further test the influence of new agricultural practices in soil quality. Information already collected from WP2 and WP5 was successfully used and contributions from the Case Study Sites in the identification of preliminary sites for testing were crucial to reach the *Milestone 1 – Selection of sites for testing and evaluation*.

Task 6.2 has started also as predicted in Month 14 to identify the parameters/indicators to assess soil quality and crop production with main activities being bibliographic review and communication/discussion sessions with partners from WP3 and WP5.

Details for each Task

Task 6.1 - Selection of sites for testing, evaluating and demonstrating of selected 'soil improving' measures

Task description

This initial task of WP6 will build on the pedo-climatic zonation and respective spatial characterization of crop and livestock systems (WP2). It further interacts with WP5 regarding the definition of the most promising innovative practices capable of enhancing soil quality and functions and contributing to sustained crop production. Based on the definition of farming systems and pedo-climatic zones, in combination with the potential soil improving measures the sites for testing, evaluation and demonstration will be established. Local stakeholders and research institutions are involved in the identification of already existing experimental sites or adequate paired field sites that allow comparing innovative with conventional practices and assessing the already achieved impact of management changes on soil quality and crop production.

Activities and results

A total of 155 plots/farms were identified, 115 in Europe and 40 in China, covering 9 Climatic regions and the most common soil types within each region. The most identified innovative AMP's in Europe were: a) Manuring & Composting, Min-till and Crop rotation. In China the most identified AMP's were: Manuring & Composting, Residue maintenance/Mulching and no-till. Using the highest soil threats in every Case Study Site area and the relevance of AMP towards the different soil threats, 23 *Testing sites* were preliminarily selected. *Testing sites* are spread in all Case Study site areas and account for 14 different innovative AMP's (or combinations).

Task 6.2: Identification of parameter/indicator set for testing and evaluating the impact on soil quality and crop production parameters

Task description

Based on the work carried out within Task 3.1 of WP3, already during but mainly after the selection of the sites for testing and evaluation the most adequate parameters/indicators are identified to assess both the response of soil quality and crop performance to innovative management practices. At all sites, independent of pedo-climatic conditions and farming system, the same set of key parameters will be observed. In addition, dependent on pedo-climatic conditions and cropping or livestock system, condition or site-specific parameters or indicators are identified to assess adequately soil functions and/or crop performance. In order to obtain results on the impact of management practices on soil quality within the period of the project, parameters to be observed have to be sufficiently responsive to change but should not be so easily changeable as to give little indication of long-term alterations, or monitoring should focus on existing implementation sites.

Activities and results

Task started in moth 14 and is in progress, no results or conclusions yet

Task 6.3: Assess parameters/indicators (including SQAPP) for testing and evaluation of innovative management practices

Task description

Based on the definition of the key and site-specific parameters and indicators (Task 6.2), their assessment at the selected Case Study Sites (Task 6.1) in collaboration with local stakeholders and research institutions will be the core activity of this WP. The idea here is to distinguish between soil quality parameters that are responsive to changes in management in the short term and those that take several years to respond. The first ones will be assessed at the beginning of the task and again towards the end, whereas long-term change parameters will be assessed once comparing soils under contrasting management systems from long-term replicated field experiments and from paired field sites. Once available, the beta-release version of SQAPP (WP4) will be additionally employed to test the usefulness of the tool to monitor soil quality improvement. Environmental resilience will be assessed based on the study indicators assessing natural capital (soil, water, climate, and vegetation).

Activities and results

Task hasn't started yet.

Task 6.4: Organize demonstration events at selected field sites

Task description

From the existing long-term experiments and on-farm field sites some will be selected to organize demonstration events in order to communicate the impact of specific management practices on soil quality as well as on crop performance. At these events, the use of SQAPP will also be demonstrated. Local and regional, as well as European stakeholders will be involved in these events to guarantee the maximum outreach of the innovative practices and the tool capable to assess soil quality.

Activities and results

Task hasn't started yet.

1.2.7 Work Package 7

WP7 is not yet active.

1.2.8 Work Package 8

Summary

The purpose of this WP is to identify ways in which the data, increased understanding, specific tools and indicators and more empirical insights from the project as a whole can be deployed in policy relating to soils, with particular reference to the CAP. It is widely understood that the pressures on agricultural soils in Europe can be detrimental, both environmentally and to the productive capacity of farmland. However, there are a number of barriers to the design and implementation of policies to ameliorate these pressures and to improve management. These barriers include the difficulties of accessing scientific and agronomic data and deploying it at the appropriate level in order to design policy measures which are valid and efficient in a range of different agricultural conditions. The costs and practicalities of monitoring soil characteristics on more than a small scale have inhibited policy making in many Member States. It can be difficult to specify those management practices required to meet soil quality objectives in a way which is both precise and relevant to variations in soil, cropping patterns, climate and weather conditions, etc. There is a lack of credible low cost tools which farmers can use to appraise soil conditions and plan management changes in relation to variable requirements including, for example, enhanced carbon sequestration.

The project will generate both data and accessible, cost efficient tools (i.e. SQAPP) which farmers will be able to utilize in order to monitor and respond to changes in the critical parameters of the soil on their holdings. These insights and outputs can be applied to policy at different levels, from the broader European scale/level down to the individual farm. Lessons will be drawn from the different WPs to help design policies which introduce obligations on farmers, such as the GAEC component of cross-compliance, and those which involve voluntary agreements, such as agri-environment schemes. Soil monitoring tools have the potential to allow a more proactive role for farmers in meeting defined objectives and will assist the capacity of public administrations to evaluate the efficacy of different management practices. Policy measures then can be better calibrated to the most effective forms of management and progress made towards a predominantly results-based approach in agri-environment policy. The analysis will support wider policy conclusions relevant to measures in the current programming period and to the design of the next set of CAP reforms to be completed by 2020.

Table 12 summarises activities completed under the different objectives of the work package. It should be noted that the objectives are closely linked to the deliverables under the work package, the first of which is due in month 27 of the project. Therefore, work has been systematically completed in line with the objectives, as set out below; however, no objectives are yet completed against in full given the relative early stage of the work.

Table 12. Summary of progress activities under the different objectives.

Objective	Description	Summary of Progress
Undertake a stocktaking of existing policy measures aimed at improved soil management and the scientific foundation on which they are constructed	This objective essentially translates into Task 1 of the WP and deliverable 8.1 due in month 27.	An initial review has been completed of policies active at EU level relevant to soil protection on agricultural land, a more detailed review has been completed for Agricultural policies and the CAP. National policies in the EU 28 Member States have been examined to understand which Member States apply policies that might influence agricultural soils and their protection. Two training sessions on the role of the CAP in soil protection have been provided for project partners to inform the development of the project and direction of analysis on agricultural policies. A webinar for over 30 iSQAPER experts in February and a half day interactive training session at the June Project Pleanary Meeting. More detailed case studies looking at good practice examples of policies have been identified – to be elaborated in the next phase of work. Initial questionnaires have been completed with Chinese officials in relation to their perceptions of soil protection and policies in China. Initial review and analysis has been completed on the SDGs and the development of the concept of Land Degradation Neutrality to inform policy understanding at a global level. A list of policy priority areas in terms of key concepts, issues and areas of policy making that will be important into the future has been identified and separate briefings will be drafted in the next phases of the work.

Draw on earlier WPs, extracting policy relevant data and insights for the design of specific measures addressing agricultural soils	This objective essentially translates into Task 2 of the WP and deliverable 8.2 due in month 50.	While the main focus of work will be later in the project initial discussions have been undertaken both in terms of understanding and inputting to the design of data collection and the use of data in the project. Specifically, discussions have been held with Task 8.5 in particular regarding relevant questions to enable data to be translated to provide policy insights and links to policy actions and with partners undertaking mapping activities under WP2 and 3. Training completed for all iSQAPER participants on the CAP was intended to provide insights on tailoring of analysis to be relevant to the political and policy context.
Demonstrate how SQAPP can be utilized for different policy purposes, e.g. in cross compliance and agri-environment measures	This objective essentially translates into Task 3 of the WP and deliverable 8.3 due in month 56.	While the main focus of work will be later in the project initial discussions have been undertaken both in terms of understanding and inputting to the design and data collection for the app. Discussions have also been held strategically in IEEP to identify policies or policy implementation needs where the app may be of use. Training completed for all iSQAPER participants on the CAP was intended to provide insights on tailoring of app to be relevant to the political and policy context.
Draw wider policy conclusions relevant to the green components of Pillars 1 and 2 of the CAP aiming at the design of more efficient and effective measures, particularly post 2020	This objective essentially translates into Task 4 of the WP and deliverable 8.4 due in month 58.	While the main focus of work will be later in the project initial discussions have been undertaken across partners in WP8, WP9 WP7 and with project coordinators to try to pulling out common themes and policy areas that can provide a thread throughout the work under iSQAPER and provide for coherent conclusions. Preparatory analysis of the elements of pillar 1 and 2 of relevance has been undertaken. Training completed for all iSQAPER participants on the CAP was intended to provide insights on tailoring of analysis to be relevant to the political and policy context.

Details for each Task

Note: tasks are described separately but progress is discussed across all tasks.

Task 8.1: Undertaking a stocktaking of existing policy measures aimed at improved soil management (Lead partner: IEEP, partners: Case Study Site partners)

This creates a baseline for further work in following tasks. It elucidates the measures now being taken specifically to address soil related concerns in different farming systems, including organic agriculture. The purpose is to establish how far policy measures could be informed and enhanced by the results of earlier WPs and the scope for initiating innovative approaches in future. The stocktaking survey is selective rather than comprehensive but covers a range of different Member States and farming systems, so that it is sufficiently representative of the EU as a whole, also taking account of experience in China as appropriate. Problems identified in designing, implementing and monitoring policy measures at different scales will be documented and key cross-cutting issues identified.

Task 8.2: Drawing on earlier WPs to extract policy relevant data for the design of specific measures addressing agricultural soils (Lead partner: IEEP, partners: BothEnds, UNIBE, UE, MEDES)

WPs 2-7 will generate a range of insights, specific data and documentation of the experience of multiple stakeholders in different parts of Europe and China, and other information, which will potentially be applicable in different policy settings at different scales. This needs to be assembled in such a way as to have the greatest direct relevance to policy practitioners, including farmers, extension workers, and those engaged at the field level. This will take a number of forms, including short summaries of key findings, illustrations of best practice, and selective references of readily digestible research findings to be prepared, presented and disseminated in collaboration with WP9. Guidance on the utilization of new approaches, implications for monitoring, administration, and public expenditure, and insights into engagement with stakeholders will be prepared.

Task 8.3: Demonstrating how SQAPP can be utilized for different policy purposes, e.g. in cross compliance and agri-environment measures (Lead partner: IEEP, partners: UPM, UE, Case Study Site partners)

Once SQAPP has been refined and assessed under different conditions in Europe its practical application in monitoring soil quality for policy purposes will be explored in this task. Applications might include roles in ex-ante and ex-post assessments of soils where policy interventions are being concentrated, broader assessments of the need for and potential scope of changes of management, allowing fine tuning of policy measures and possible applications at farm level, where farmers are obliged or incentivised to undertake more focussed analysis of soil conditions and develop remedial measures. These applications will be summarised in a report identifying the key issues arising from the perspective of different stakeholders, who have been introduced to the tool, including public administrations.

Task 8.4: Drawing wider policy conclusions relevant to the green components of Pillars 1 and 2 of the CAP aiming at the design of more efficient and effective measures, particularly post 2020 (Lead partner: IEEP, partners: BothEnds, UPM)

The final analysis will apply the results of the foregoing tasks to the policy agenda at the time of the completion of the project, around 2019. This includes an overview of ways in which policy could be more finely tuned to a range of concerns about soil quality and functionality from the local and regional up to the European scale. It will help to sharpen policy design and strengthen assessments of the scale of management change which might be required to meet key soil objectives in different regions and systems and so inform a new generation of policies which will be in the process of being developed towards the end of the current CAP programming period as draft legislation is prepared for policy after 2020.

Description of the Work Completed

Tasks 8.2 through 8.4 are focused primarily in the latter end of the iSQAPER project, resulting in deliverables between month 50 and 58. Therefore activities under these tasks have been limited. However, preparatory work has been completed to set the scene for the work including:

- Training on the CAP, the nature of policy making and the actors this encompasses – two sessions including a Webinar in February 2016 and a half day training session at the Plenary Project Meeting in Hungary in June 2016 intended to provide all project partners with a baseline understanding of the key instrument regulating agricultural management in Europe and initiate discussion on the aspects and issues to be brought through within iSQAPER. Training material is available upon request.

- Discussions on the development of common themes to run through the analysis of WP8, WP7, WP5 and with the coordinators held both during plenary session side discussions and also during planning meetings including a coordination meeting held between WP8 and WP7, 5, 9 and project coordinators in February 2016.
- Discussions with the WP3 and 4 experts to understand potential data and presentation of information in the app to understand policy relevance and help ensure usability from a policy implementation perspective.
- Discussions with WP2, WP3 and WP5 regarding the data being generated and how this might be tailored or contextualised to provide messages relevant to policy makers.

Task 8.1 has been the focus of activities to date under WP8, building towards submission of deliverable 8.1 in month 27. In early 2016 coordination and scoping meetings were held both within IEEP (involving different elements from our multidisciplinary team including experts on climate, water, soil, biodiversity and agricultural management issues and policies) and with other work package leaders and other WP8 partners. This was intended to scope out areas and potential issues of interest. The result was a short list of concepts and priorities upon which to focus Task 8.1 analysis. Building on this and to validate the core teams prioritisation a short questionnaire was completed by each partner/attendee at the plenary session in Hungary in June 2016. This was intended to allow the team to understand the perceptions of soil protection, policy and policy making across the iSQAPER case studies, partners and the countries in which the operate (including the regional perspectives from China).

Coordination has also been undertaken with leaders of policy analysis taking place other H2020 projects focused on soil protection including RECARE and Soil Care. This was intended to ensure that information or at least approaches are shared across projects to avoid duplication of the policy scoping exercise and ensure the projects independently and as a group add value.

The core effort completed so far under Task 8.1 has focused on the generation and collation of knowledge of policies in place to protect agricultural soil in Europe. This has been followed by the systemic review of policies at EU level and national level (and in some cases regional level) in Europe that impact on the protection of soils on agricultural land. This has consisted to date of a primarily desk and literature based review of policies relevant to the protection of agricultural soils. Based on the policy understanding a scoping exercise was undertaken to identify areas for further investigation. This takes into account EU policies in particular on agriculture, water protection, air quality, climate mitigation and adaption at the EU and national level.

A methodological approach is under development with the intention of complementing the literature based analysis with more detailed information, interviews and first hand experiences of key measures of interest in the form of mini case examples. This additional analysis will be completed in Spring 2017.

Task 8.1 is not only focused on policies in Europe but also the international agenda and context and policy actions in place in China. Based on discussions with partner organisations based on China at the Hungary Plenary meeting, two questionnaires were developed in June/July 2016 to provide an initial exploration of policy issues and factors of importance. Questionnaires were tailored to provide questions relevant to farmers and separately questions relevant to policy makers/academics. First results from the questionnaires have been reviewed. In Spring 2016 the team will build on key messages emerging to investigate issues and questions in more detail. This will include further discussions with Chinese partners and potential site visits as needed.

The international agenda and in particular the Sustainable Development Goals and developments under the UNFCCD on the concept of Land Degradation Neutrality are important context for iSQAPER's work. Moreover, process especially linked to the LDN development and analysis offer a potential opportunity for iSQAPER both to feed in expertise and for the promotion of interest and monitoring of soils – relevant to the app development. BothEnds have been taking the lead in terms of the analysis of the LDN concept including the participation and contribution to the conceptualization and governance of Land Degradation Neutrality within the Science Policy Interface of the UNCCD. A policy briefing is under development focusing on LDN to be finalised in early 2017. An iSQAPER training session for the partners in the consortium on the SDGs and LDN was completed in December 2016 building on understanding gathered by BothEnds and IEEP.

Based on the analysis completed so far, and discussions with both partners and stakeholders, regarding useful and usable outputs from WP8; the team have concluded that focusing in on messages around a number key themes would help move forward discussions. Therefore, a series of policy briefs each up to 10/15 pages in length will be produced starting in Spring 2017. Key topics proposed include:

- The policy priorities and soil protection – overview briefing on integrating soil functions and services into policy delivery in other policy areas including water protection
- The role of Agricultural Policy in protecting soils
- Conceptualising land degradation neutrality
- Climate change and soils: the role of policy
- Soil organic matter: protection, promotion and monitoring

1.2.9 Work Package 9

Summary

The objectives of this WP are:

1. to coordinate and facilitate contact and communication with the different groups of actors and target audiences who will be involved in iSQAPER, potential users of SQAPP and the wider public and
2. to ensure efficient and effective dissemination of knowledge generated in the project using a variety of media and methods as appropriate for the different actors and target audiences.

To achieve these objectives, the WP is comprised of 5 tasks: the development of the iSQAPER Dissemination and Communication Strategy (Task 9.1); the development of methods of knowledge transfer and dissemination (Task 9.2); the iSQAPER information system (Task 9.3); promotion of SQAPP (Task 9.4); and iSQAPER – visual impact (Task 9.5).

Summary of progress towards objectives: During the first reporting period activity has focused on two of the five tasks. The first draft of the Dissemination and Communication strategy (Task 9.1, Deliverable 9.2) has been written with key messages from each study site and WP provisionally identified for different target audiences (or stakeholder groups). The iSQAPERiS website has been set up with most of the necessary functionality and a provisional structure designed to enhance the communication of the research results (Task 9.3).

The other three tasks have not been active in this period although discussions have been held about a partner training event in the next period (Task 9.2) and initial ideas have been developed for the film (Task 9.5).

Details for each Task

Task 9.1 The development of the iSQAPER Dissemination and Communication Strategy

Task description

This task covers the specifications for what knowledge will be transferred and disseminated, to whom and when. It will include:

i. identification of the key messages resulting from the research programme
ii. identification of the target audiences for those messages.
iii. scheduling the communication activities

(These three points concerning details of the iSQAPER exploitation and dissemination of results for each work package and study site will be reported in Chapter 2 of the iSQAPER PEDR).

iv. management of knowledge and intellectual property rights in accordance with the Consortium Agreement and Data Management Plan.

(This point concerning Open Access and the Data Management Plan will be reported in Chapter 5 of the iSQAPER PEDR.)

Activities and results

Details of the iSQAPER exploitation and dissemination of results for each work package and study site

While the project as a whole has a number of general key messages to deliver, each work package and study site has distinct and different messages according to the research theme and local situation of each and the particular audiences the messages are intended for. Consequently Chapter 2 is divided into separate work package and study site-specific sections:

Work packages:

- WP01&09 Coordination & Dissemination and communication (this section refers to the project and iSQAPERiS websites, social media and project-wide dissemination products such as the project leaflet)
- WP02 Analysis of crop and farming systems across pedo-climatic zones
- WP03 Existing soil quality indicator systems
- WP04 Development of SQAPP
- WP05 Stakeholder inventories of soil quality and innovative practices
- WP06 Measures to improve soil quality
- WP07 Upscaling practices and assessing environmental footprint
- WP08 Policy analysis and recommendations

Study sites:

- SS01 De Peel, NL
- SS02 Argentré du Plessis, FR
- SS03 Cértima, PT
- SS04 Costera, ES
- SS05 Crete, GR
- SS06 Lubljana, SI

- SS07 Zala, HU
- SS08 Braila County, RO
- SS09 Trzebieszów, PL
- SS10 Tartumaa, EE
- SS11 Qiyang, CN
- SS12 Suining, CN
- SS13 Zhifanggou Watershed, CN
- SS14 Gongzhuling, CNSS01

Each section follows the same common format, listing:

- **Key messages** the 3 or 4 main pieces of information (partly derived from the objectives stated in the work package descriptions but also (for the study sites) from asking stakeholders what information they are interested in getting from the project (Milestone 5.1).
- **Stakeholder groups and individuals**, grouped according to the spatial scale at which they operate and identified as specifically as possible. Again, for the study sites, this information has been obtained from interviews (Milestone 5.1).
- (for the study sites) **Work package tasks that provide dissemination opportunities**
- **Record of dissemination** listing information provided, target audience or stakeholder group, format or media, date delivered.
- **Scientific publications**

The sections are also all stored as Google Sheets and are accessible to the relevant consortium partners for regular update.
During the first reporting period, the dissemination plans for each work package and study site went through two iterations of revision, the first following the plenary meeting in Vitré, the second following the plenary meeting in Hungary. See Chapter 2 of the PEDR for the current version.

Open Access and the Data Management Plan
iSQAPER will take part in the Commission's extended pilot on open access to research data. Details about

- Open Access and
- Data Management Plan

will be developed in the next reporting period and included in Chapter 5 of the PEDR.

Task 9.2: The development of methods of knowledge transfer and dissemination

Task description

This task covers the specifications for how knowledge will be transferred and disseminated. It builds on methods developed and successfully used in earlier projects DESIRE and CASCADE. It will include:

i. design of document and presentation templates for project-wide use in all types of dissemination including newsletters and factsheets, posters, press-releases and presentations;

(This point concerning iSQAPER visual identity will be reported in Chapter 3 of the iSQAPER PEDR)

ii. methods of preparing/rewriting/reorganising project deliverables for dissemination to different target audiences or for different purposes (such as a press release);
iii. methods for communicating with and maintaining the engagement of the target audience and those involved in developing SQAPP over a number of years. This will include the use of email lists, meetings, video clips and podcasts and workshops;
iv. training project participants in the use of the different methods of knowledge transfer and dissemination.

(This point concerning building dissemination and communication skills in the consortium will be reported in Chapter 4 of the iSQAPER PEDR)

Activities and results

iSQAPER visual identity

During the first reporting period work was completed on establishing the key elements of iSQAPER visual identity.

The project logo with the subtitle "interactive soil quality assessment" shows a field and its underlying soil profile under a magnifying glass (Figure 18).

Figure 18. Project logo

See Chapter 3 of the iSQAPER PEDR for additional details regarding the project's visual identity including the adaptation of the logo for the app, hexadecimal colour codes, website header, home pages of the project and iSQAPERiS websites, project leaflet, and templates for presentations.

Templates for newsletters, factsheets, posters and press-releases will be developed as required in the next reporting period.

Building dissemination and communication skills in the consortium

Activities to build dissemination and communication skills in the consortium will be developed, as required by the work programme, in the next reporting period.

Task 9.3: iSQAPER Information System (iSQAPERiS)

Task description

The iSQAPERiS website will be the project's major dissemination product. In contrast to the project website (which will be used for internal organisation and management of the project), iSQAPERiS will present the key messages and scientific results making them available and accessible to all the stakeholders and target audiences.

Activities and results

iSQAPERiS is built in Joomla! an open source content management system with powerful functionality. The iSQAPER DOW described the likely specifications for the website as follows:

- A "Quick start guide" incorporating video clips to enable the user to familiarise him/herself with the key contents of the system;
- A menu structure adapted from iSQAPER's organisational structure with sections for each research theme and Case Study Site and designed to provide answers to questions such as "What are soil quality, agricultural productivity and environmental resilience?", "Why are they important?" "How can soil quality be assessed?" "What can be done to improve soil quality?" "How can improving soil quality increase agricultural productivity and environmental resilience?" The explanations given will be in more depth and in addition to that provided by SQAPP and will support SQAPP users and others in their understanding of the issues surrounding soil quality;
- The content organised hierarchically, with the degree complexity of information increasing with each level.
- All complete deliverables will be available for downloading and many will be reformatted for on-line reading. However the user may choose to read only the summary/poster introductions;
- Interactive tools will be used to simplify the presentation of complex information, as will Powerpoint slideshows, short video clips or animations;
- Basic website functionality will be extended to include: a document management component which provides an interface for downloading all documents; a photo gallery with titles and captions for every image; a fully-integrated glossary; interactive Google maps; a facility for translating and reading as much content as desired in the Case Study Site local languages.

During this reporting period the prototype iSQAPERiS was been set up according to these general specifications. It can be seen online at http://www.iSQAPER-is.eu/. Full details of the design, structure and organisation of the website are given in Deliverable 9.1. In the next period effort will be concentrated on adding content from the deliverables as they become available. Table 13 summarises the current status of deliverables.

Table 13. Current status of deliverables

Section	Sub-section	Articles
		Some content already available on iSQAPERiS Source deliverables are available, but material has not yet been extracted for iSQAPERiS Deliverables not yet available
Key messages	Booklets, factsheets and video clips provide information about soil quality in succinct and easy to read formats.	
Assessment	Operationalising soil quality: innovative methods to assess soil quality in different pedo-climatic zones, integrating soil science, agricultural and land management practices.	
	Concepts of soil quality indicators	Critical review of existing concepts of soil quality indicators [D3.1 month 16]
	Soil quality indicators	Critical review of soil quality indicators with respect to their sensitivity to indicate soil threats and soil functions and interactions with management as well as reliability and simplicity of measurement [D3.2 month 19]

	New indicators	Report on the potential for new indicators of soil quality and gaps in knowledge to realize those [D3.4 month 38]
	Pilot tool	Pilot soil quality assessment tool [D4.1 month 24]
Indicators	Tailoring soil quality indicators for wide-ranging conditions: Soil quality indicators tailored for and tested by farmers for farmers in Europe and China.	
	Pedo-climatic zonation	Hierarchical and multi-scale pedo-climatic zonation [D2.1 month 9]
	Crop & livestock systems	Classification of crop and livestock systems [D2.2 month 14]
	Spatial analysis	Report on the spatial analysis of crop and livestock systems in relation to pedo-climatic conditions [D2.3 month 20]
	Aggregate indicators	Report on a) soil quality status of trial sites, b) interactions between climate, topography and agricultural systems on indicators of soil quality, and c) evaluation of the best subset of measurements for (aggregate) indicators of soil quality [D3.3 month 38]
	Case study sites	Soil quality inventory of Case Study Sites [D5.2 month 38]
New Standards	Setting a new standard in soil quality assessment: An app for mobile devices anywhere in the world, providing location-specific soil quality information and sustainable land use management options.	
	SQAPP	Tested and validated final version of SQAPP [D4.2 month 56]
	Agricultural management	Database of currently applied and promising agricultural management practices [D5.3 month 48]
Multi-actor Approach	Underpinning SQAPP development by a multi-actor approach: The app will be developed, tested, evaluated and improved by farmers, scientists, practitioners, agricultural service providers and policy makers.	
	Stakeholder feedback	Report on stakeholder feedback to soil quality assessment tool [D5.1 month 32]
	Management recommendation	Internal report on performance of promising land management practices to populate recommendations of the SQAPP [D6.1 month 48]
	Indicator performance	Report on the performance of key and site-specific parameters and indicators for all monitored sites [D6.2 month 54]
	Existing policy measures	Initial stocktaking report on existing policy measures [D8.1 month 27]
	Policy relevant information	Inventory of policy relevant data and sources extracted from WPs 3-7 and applicable to policy design [D8.2 month 50]
Ecosystems Services	Linking soil quality and provisioning of ecosystems: Information about the environmental footprint of farming activities, options for sustainable land use and the effects of widespread adoption of sustainable land practices generated from existing databases and shared among farmers, scientists, regional and national policy makers.	
	Effect of farming on soil quality	Report on definition of typical combinations of farming systems and agricultural practices in Europe and China and their effects on soil quality [D7.1 month 36]
	Effect of management on quality	Report on key management practices

		affecting soil quality [D7.2 month 44]
	Soil management scenarios	Report on scenarios of future farm and soil management systems [D7.3 month 52]
	Policies and environmental footprint	Report on the evaluation of scenarios of changed soil environmental footprint for a range of policy scenarios [D7.4 month 56]
	Lessons for policy	Final conclusions on lessons for agricultural and environmental policy, including the post 2020 CAP [D8.4 month 58]
	Applying SQAPP	Short report on applying the soil quality tool to different policy challenges and settings [D8.3 month 56]

Task 9.4: Promotion of SQAPP

Task description

This task will promote the widespread uptake of SQAPP and will be reported in the Dissemination and Communication Strategy. It will include:

i. providing a dedicated download facility for SQAPP on the iSQAPERiS.
ii. feature articles on iSQAPERiS about the development of SQAPP including, for example, feedback and preliminary analysis data from the beta-release version to demonstrate its uptake and use;
iii. video clips in iSQAPERiS showing the use of SQAPP in different areas and by different users;
iv. providing links between the SQAPP development fora and the iSQAPERiS;
v. making use of the network of target audiences and stakeholders to promote SQAPP.

Activities and results

This task was not due in this reporting period.

Task 9.5: iSQAPER – visual impact

Task description

Television remains the main source of scientific information for the general public. This task is to develop a number of different video or film products which explain the scientific issues underlying soil health. The films will be made available on YouTube and Vimeo, accessed through iSQAPERiS or possibly broadcast in collaboration with a European and/or Chinese television company.

Activities and results

During this reporting period exploratory visits have been paid to several iSQAPER locations.

1.3 Impact

For each of the five expected impacts (italic headings below) set out in the work programme under the call topic, the main impact results are summarized and categorized into scientific (**S**), technological (**T**), agro-environmental (**AE**), and policy (**P**) related ones. These impacts have not changed relative to the DoA, but have still been summarised below. In addition, the European – Chinese partnership in iSQAPER is generating significant opportunities for co-learning and integration of knowledge, which is likely to extend beyond the project. This is an additional impact not yet fully anticipated during the development of the DoA.

Improved capacity and methods to assess soil-management interactions and their impact on soil functions

iSQAPER aims to explore, in more detail than currently available, the interactions between land management practices and changes in soil properties and function. The principal expected impact will be i) a harmonized scientific approach describing the cause and effect relationships of different land management practices on soil properties and function, covering different farming systems and pedo-climatic zones across Europe and China, for practitioners and beyond (**S**), ii) a set of rules, that will be the central element of the soil quality assessment tool, enabling comparison of results across time and space (different sites, farming systems, etc) (**S**), and iii) compilation of targeted land management options for different farming systems capable of improving soil quality while maintaining or even increasing crop productivity and yield stability (**S**).

Widely accessible and cost efficient tool to monitor the 'health status' of agricultural soils by practitioners in the agricultural sector

Within iSQAPER WP4, a widely accessible and cost effective tool to assess and monitor the quality of agricultural soils will be developed based on integrating state-of-the-art soil physical, chemical and biological knowledge with site specific data, indicators, and modelling approaches. The main expected impacts will be generated through i) the technological environment that will be constructed, based on wireless applications, background databases, and a dedicated mobile web platform, integrated to provide practitioners and other potential end-users with a user friendly application to assess the quality of soils in use for agricultural production (**T**), and ii) easy access and cost-efficient use of the soil quality tool by ensuring its use on a range of different electronic devices, independently of type, operating system, and geographical location (**T**).

Increases in crop productivity, quality, and yield stability in conventional and organic farming systems through improved practices for soil husbandry including crop rotations

One of the main aims of iSQAPER is to maintain and preferably increase crop productivity and yield stability through introduction and adoption of agricultural land management practices which ensure a certain level of soil quality. The main impacts foreseen are i) multi-stakeholder selection, implementation and evaluation of promising land management practices within each of the iSQAPER Case Study Sites (**S,T,AE**), ii) demonstration of best agricultural land management practices to Case Study Site stakeholders aiming at knowledge exchange, awareness raising, and stimulating other land users within and outside the Case Study Sites to also adopt alternative land management practices in order to improve the quality of agricultural soils and concurrently increase crop productivity and yield stability (**AE,P**).

Enhanced climate and environmental performance of agricultural activities (e.g. through reduced adverse impacts on agricultural soils)

Within iSQAPER, the relationship between soil quality, crop productivity and yield stability, and ecosystem services (among others) will be investigated, analysed, and quantified for agricultural activities deployed by land users in different farming systems across major pedo-climatic zones of Europe and China. The main impacts to be expected from iSQAPER are i) insights and guidance for farmers across Europe and China on selecting agricultural activities that contribute to enhanced climate and environmental performance, soil quality stewardship (including crop productivity and yield stability) (**S,AE,P**), ii) uptake and implementation of agricultural activities by farmers inside and outside the Case Study Sites enhancing climate and environmental performance while providing quality for soil and livelihood conditions (**AE,P**).

Support to CAP environmental objectives and development of further policies in the area

The agricultural sector is expected to expand in the face of increased demands for food, fibre and energy. iSQAPER will offer insights into how best to use the opportunity of the on-going reform of the Common Agricultural Policy (CAP) to improve the sector's resource efficiency and environmental performance and reduce its impact on soil, water, air, biodiversity and landscape. The main impacts foreseen are i) improvement of agricultural resource efficiency and environmental performance across the iSQAPER Case Study Sites, and beyond (**AE,P**), ii) targeted policy recommendations at regional, national, European, and Chinese level contributing to the on-going reform of the CAP (**AE,P**).

2. Update of Plan for Exploitation and Dissemination of Results (PEDR)

The PEDR is a dynamic document that will updated regularly during the implementation of the project. It is divided into 6 chapters

Chapter 1.	Orientation
Chapter 2.	Details of the exploitation and dissemination of results for each work package and study site
Chapter 3.	iSQAPER visual identity
Chapter 4.	Building dissemination and communication skills in the consortium
Chapter 5.	Open Access and Data Management
Chapter 6.	Evaluation of the effectiveness of the PEDR

During this reporting period the first version of the PEDR has been prepared and submitted as Deliverable 9.2.

3. Update of data management plan

Discussions about the Data Management Plan (DMP) started at the kick-off plenary meeting in Vitré. It has taken longer as planned to develop a version 1.0 of the DMP due to the timing that datasets to be produced are being shaped and it becomes clear what data they will contain, and what connections to other datasets and (potential) uses and users can be identified. Therefore, the first full version of the DMP has been delivered at the end of the reporting period (Deliverable 1.2), and contains guidance on how to develop FAIR data management details for datasets when they are being prepared. As such, the current version of the DMP reflects the the most recent state of play. Open Access and the Data Management Plan (DMP) will be reported in Chapter 5 of the iSQAPER PEDR.

4. Follow-up of recommendations & comments from previous review(s) (If applicable)

Not applicable.

5. Deviations from Annex 1 (DoA)

5.1 Tasks

Work Package 3

Task 3.3: Assess how soil type, climatic zone, topography and crop and land management interact to affect indicators of soil quality

Within the framework of testing a set of soil quality indicators across selected long-term experiments (LTE), it was considered important to analyse all soil samples in the same certified lab in order to avoid variation in methods and accuracy. For chemical and physical indicators the lab of University of Ljubljana (UL) was selected based on price quality ratio. As a project partner, UL can however not be paid by LTE owners. Therefore, it was agreed that all LTE owners would accept a budget reduction and UL would be allowed to overspend. The implicated budget shifts are:

- FiBL (Partner 3): - € 3,080
- DLO (Partner 10): - € 3,696
- UL (Partner 13): + € 12,397 (total minus costs for own LTE samples of € 1,848)
- UMH (Partner 15): - € 2,310
- IPC (Partner 16): - € 693
- UP (Partner 23): - € 2,618

Work Package 5

Task 5.3: Selection of innovative agricultural management practices

In order to identify new or 'improvable' practices for test implementation, a structured process of joint selection and negotiation within a multi-stakeholder participative workshop was basically planned to be conducted at each case study site. For the reasons mentioned below, this workshop was moved to after the field trials and the list of innovative AMPs was established without involving the stakeholders.

Task 5.3 was changed to overcome a planning error from the proposal: while the selection of sites for testing and evaluation has to be done on Month 18 by WP6 (M6.1), the selection of innovative AMPs was basically planned for Month 24 (WP5, M5.2). As the Milestone M6.1 (WP6) is based on the outcomes of M5.2 (WP5), Task 5.3 has thus been changed into a multi-stakeholder process of evaluation rather than selection of AMP *after* the field trials. However, M5.2: Selection of innovative AMPs has been brought forward in form of a list of AMPs and was delivered to WP6 on Month 17 instead of Month 24 as originally planned.

Work Package 8

At the project plenary meeting in June 2015 it was discussed and agreed that WP8 policy understanding and relevant expertise of the partners should be integrated into the working and scoping of iSQAPER from an earlier stage that originally envisaged in the proposal. This was to ensure that the strategic direction and decisions in terms of the work package coverage encompassed the relevant policy context and took account of emerging themes relevant in terms of ensuring policy relevant outputs.

As a consequence training in the form of the Webinar and coordination meetings with other workpackages, policy scoping activities and discussions were brought forward within the project timeline. All activities were originally envisaged but completed to a slightly altered timeline to take account of the needs of project partners and ensure the cohesive working of the project.

Work Package 9

Task 9.1: The development of the iSQAPER Dissemination and Communication Strategy

In order to bring reporting of iSQAPER's dissemination and communication activities in line with current recommendations for Horizon 2020 projects (European IPR Helpdesk Fact Sheet The Plan for the Exploitation and Dissemination of Results in Horizon 2020, July 2015) it is proposed to rename Deliverable 9.2 "Dissemination and Communication Strategy" as "Plan for the Exploitation and Dissemination of Results (PEDR)" and to expand its contents to include Open Access to Publications and Research Data and the Data Management Plan.

5.2 Use of resources

Partner 1: WU

At the start of the project, a joint PhD between Wageningen University, FiBL and DLO has been conceived, which has changed the input of person months to WP3. Accordingly, the tasks related to WP3 translate in an input of 23 PM for Wageningen University, of which roughly 19 PM are accounted for by the PhD (Giulia Bongiorno) and about 3 PM are accounted for by Ron de Goede and Lijbert Brussaard, mainly for supervision of the PhD. An additional 1 PM is contributed by Violette Geissen. The total rounded figure of 17.27 PM includes the following:

- Geissen V. senior researcher 0.53 PM, amount hours 70
- Brussaard L. prof. 1.12PM, amount hours 148
- de Goede R. senior researcher 1.64 PM, amount hours 216
- Bongiorno G. researcher 13.98 PM , amount hours 1843

Partner 7: IEEP

At the project plenary meeting in June 2015 it was discussed and agreed that WP8 policy understanding and relevant expertise of the partners should be integrated into the working and scoping of iSQAPER from an earlier stage that originally envisaged in the proposal. This was to ensure that the strategic direction and decisions in terms of the work package coverage encompassed the relevant policy context and took account of emerging themes relevant in terms of ensuring policy relevant outputs.

As a consequence training in the form of the Webinar and coordination meetings with other workpackages, policy scoping activities and discussions were brought forward within the project timeline. All activities were originally envisaged but completed to a slightly altered timeline to take account of the needs of the other project partners and ensure the cohesive working of the project. By bringing tasks forward, use of resources is accordingly more equally spread over the course of the project.

Partner 8: MEDES

Resources have been used according to the DoW and no major deviation occurred during the current reporting period. The table below reports details per WPs.

	Planned person months in reporting period[a]	Actual person months in reporting period
WP1	0.62	0.59
WP2	-	-
WP3	-	-
WP4	0.32	0.31
WP5	1.6	1.59
WP6	0.5	0.5
WP7	0	0
WP8	0	0
WP9	6.15	5.93

[a] Person months in the Description of Action (i.e. Annex I of the Grant Agreement) are specified per Work Package. This is an estimate of the person month distribution over WPs relating to Period 1.

Partner 10: DLO

Time claimed on WP1 (1.65 person month) concerns the contribution of Klaas Oostindie to project management tasks as member of the project coordination team.

Partner 12: Eesti Maaülikool

There are changes in team composition relative to the DoA as PhD students are involved. For the PhD students lower salary was paid for the same period compared to the permanent staff, thus the number of person months at the same amount of money is higher.

	Planned person months in reporting period[a]	Actual person months in reporting period
WP1		
WP2	0.75	2
WP3	3	4.61
WP4	0	0
WP5	4.5	4.5
WP6	1	1.57
WP7	0	0
WP8	0	0
WP9	0.5	0.95

[a] Person months in the Description of Action (i.e. Annex I of the Grant Agreement) are specified per Work Package. This is an estimate of the person month distribution over WPs relating to Period 1.

Partner 13: UL

According to the DoA 4 person months are available on WP3. Because UL carried out the soil analyses for LTE, UL spent 5.1 person months more on WP3. The total rounded figure of 9.1 person months includes the following:

- Matjaž Glavan, 4 PM, amount hours 564
- Svetlana Gogić Knežić, 1.92 PM, amount hours 274
- Rozalija Ilc, 1.92 PM, amount hours 274
- Vili Šijanec, 0.7 PM, amount hours 100
- Iren Tič, 0.31 PM, amount hours 45
- Marko Zupan, 0.28 PM, amount hours 40

Partner 14: ICPA

The table below gives an overview of actual person months reported relative to the total project.

	Planned person months in project	Actual person months in reporting period
WP1	-	-
WP2	3	-
WP3	5	1
WP4	5	-
WP5	15	4
WP6	15	1
WP7	3	-
WP8	2	-
WP9	2	-

- The work for Tasks from WP2 on classification of soil, climate and land use is described in Task 6.1 from WP6, which is related to WP2. Therefore, the effort of ICPA of 1 person month was allocated to WP6.
- The work for Task 3.2 from WP3 on documentation of existing field trials, to which ICPA contributed, required only the effort of 1 person month in order to be accomplished.
- The work for Tasks 5.1 and 5.3 from WP5 on stakeholder selection and selection of innovative agricultural management practices, to which ICPA contributed, required the effort of 4 person months, but the work has not yet ended. For these 2 tasks, the selection of new stakeholders and new innovative agricultural management practices is a dynamic asset that will continue in the next months in order to improve the existing selections.
- Also, for the work on Task 5.3 from WP5 it was necessary to use additional 4 employees, namely 2 laboratory personnel, 1 agronomist and 1 chemist who did the soil measurements in the laboratory.
- The work for Task 6.1 from WP6 on selection of sites for testing of innovative agricultural management practices, to which ICPA contributed, required the effort of 1 person month, but the work has only just started. Soil sampling for the WP6 and the sample measurements will be done in spring of the year 2017 and, therefore, the work has been postponed till March – April 2017.
- The work for Tasks from WP4, WP7, WP8 and WP9, for which ICPA has to contribute, has not started yet.

Partner 15: IPC

The overall high person months and especially for WP6 by IPC is a result of two things: 1) we will be able to state a higher number of persons month involved in the project by the end of it, due to a judicious use of financial resources to contract personnel and to the involvement of members of staff; 2) WP6 is the WP where we envisage to have a stronger contribution, and we are more interested. So by the end of the project we will more than double the persons month foreseen for this WP, and expect to give a strong contribution to knowledge and in the number of papers published. The number of person months stated for WP6 reflects work in vineyards on large fields, experimenting with different crop variables (organic, traditional, ...) as well as biochar experiments on lysimeters that will contribute to documenting performance of AMPs.

Partner 19: ISWC

The table below gives an overview of actual person months reported relative to the total project.

	Planned person months in project	Actual person months in reporting period
WP1	0	3.5
WP2	2	2
WP3	4	2
WP4	0	0.5
WP5	15	1.5
WP6	20	1
WP7	4	0
WP8	3	0
WP9	2	0

- T1.1 and T1.5 for 1.5 month including documents and participant the meeting, T1.2 for 2 months including the financial and legal management of UNAFU and CAS;
- T2.1 for 0.5 month, T2.4 and T2.5 for 1.5 months together;
- T3.1 and 3.2 for 0.5 month each, T3.3 for 1 month; soil sampling for T3.3 and T3.4 has therefore been postponed to late April 2017;
- T4.1 and T4.2 for 0.5 month;
- T5.2 for 1 month, and T5.3 for 0.5 month;
- T6.1 and T6.2 for 1 month.

Partner 23: UP

1. Remark on other direct costs

The organization of the second plenary meeting of iSQAPER project significantly increased the other direct costs of UP in the period of 01/05/2015-31/10/2016. The meeting was held between 20/06/2016 and 23/06/2016 in Balatongyörök, Hungary. The number of participants was 53-56. Costs related to the plenary meeting sum up to 6457.07 Euro including the followings:

- working lunch, coffee: 6076.28 Euro,
- bus fare of field day - transportation of participants to the long term field experiments and study site of UP: 339.07 Euro,
- cost of specialist presentation on the geology and hydrology of the region where study site is located: 41.72 Euro.

Due to the organization of the plenary meeting, UP used most of the amount of "workshop costs" included in the grant agreement as "other goods and services".

2. Changes in team composition
Tamás Hermann, Attila Dunai and Gabriella Henger have been involved to complete the tasks of the project.

5.2.1 Unforeseen subcontracting

No unforeseen subcontracting was performed.

5.2.2 Unforeseen use of in-kind contributions from a 3rd party against payment or free of charge

No unforeseen in-kind contribution was used.