European Cooperation in the field of Scientific and Technical Research
- COST -

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COST 092/14

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action ES1406: Soil fauna - Key to Soil Organic Matter Dynamics and Modelling (KEYSOM)

Delegations will find attached the Memorandum of Understanding for COST Action ES1406 as approved by the COST Committee of Senior Officials (CSO) at its 191th meeting on 12-13 November 2014.

MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action ES1406
SOIL FAUNA - KEY TO SOIL ORGANIC MATTER DYNAMICS AND MODELLING (KEYSOM)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4114/13 "COST Action Management" and document 4112/13 "Rules for Participation in and Implementation of COST Activities", or in any new document amending or replacing them, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to establish a European network to deliver scientific syntheses of the current understanding of soil fauna-SOM interactions, and provide guidelines for future experimentation for data management and linkages between experimentalists and modellers.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 28 million in 2014 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Section *2. Changes to a COST Action* in the document COST 4114/13.

A. ABSTRACT AND KEYWORDS

Soil is a non-renewable ecosystem resource under seriously pressure by land use, urbanisation and climate change. Soil organic matter (SOM) is key to soil fertility, climate change mitigation, combatting land degradation, and the conservation of above- and below-ground biodiversity and associated ecosystem services. Existing models of SOM dynamics are defined mostly in terms of plant residues input and microbial decomposition, overlooking the important contribution of soil fauna activity. Here, the Action will bring biogeochemists and soil ecologists together to develop a research network for improved SOM models by implementing the role of the soil fauna as a basis for sustainable soil management. An international interdisciplinary approach within a COST Action is envisaged as the proper platform for both experimentalists and modellers to provide solutions. Deliverables will be provided through workshops addressing key challenges in SOM / soil fauna experimentation and modelling, support of research exchange, education of young scientists and better access to experimental data. The Action will be organised within four Working Groups to address:

1. Knowledge gap analysis of SOM – soil fauna interaction;
2. Potentials and limitations for inclusion of soil fauna effects in SOM modelling;
3. Data assemblage and data sharing;
4. Knowledge management and advocacy training;

Keywords: soil fertility, soil fauna, land use and management, soil organic matter modelling, climate change

B. BACKGROUND

B.1 General background

Soil organic matter (SOM) is key to soil fertility, improving the soil structure and associated soil moisture and aeration processes and, providing nutrients. SOM is biologically transformed by microorganisms and fauna and stabilized in organo-mineral complexes with different turnover rates. SOM dynamics represent the balance between the input of plant material (residues, root-derived materials) and the output through decomposition (OM mineralization) by organisms, erosion and leaching. This organic matter balance of the soil is important for the global carbon (C) cycle, in particular for the green-house gas (GHG) emissions from soils to the atmosphere. Approximately

20% of global CO_2 emissions, one third of global CH_4 emissions and two thirds of N_2O emissions originate from soils. Understanding the processes governing SOM dynamics is also essential for managing soil fertility, agricultural productivity and soil ecosystem services.

Biogeochemical SOM models aim at predicting the dynamics in composition and amounts of SOM and, thereby, the changes in soil fertility and global C cycling. They use very few input parameters and oversimplify the highly diverse soil community, reducing to its microbial component and decomposition and humification rate constants. The composition and activity of soil fauna greatly vary with respect to climate and land use. Changes in these alter the spatial distribution and activity of soil fauna, thereby affecting turnover rates of SOM to the extent that assumptions of current SOM models may no longer be valid.

The important contribution of soil fauna to SOM dynamics has so far been considered mainly by soil ecologists who developed their own models. These describe C dynamics mainly on the basis of trophic interactions (among microbes, micro-, meso- and macro-fauna). The engineering effects of soil fauna through the production of biogenic structures, are not specifically addressed either. As a result, there are some SOM models with a relatively detailed description of the physical/chemical processes but oversimplifying or omitting the role of soil fauna and, in contrast, soil food web models with relatively detailed descriptions of trophic interactions but oversimplifying soil physical and chemical processes (Brussaard et al. 2012). This situation is perpetual since the new scientific achievements in soil biogeochemistry and soil ecology are weakly linked due to the absence of knowledge exchange programs.

With this Action the unrecognized role of soil fauna in soil carbon dynamics and SOM models is addressed by analysing and exploring the impact of soil fauna on the following components of biogeochemical SOM models that were described in Schmidt et al. (2011), where this important component of soils was ignored:

1. Molecular structure of SOM; role of faunal casts and excreta in dynamics/turnover of humic substances and biogenic elements.

2. Soil aggregate formation: stability of biogenic structures, especially faunal excrements like earthworm casts, patterns of their microbial colonisation and degradation dynamics, as compared with physicogenic aggregates and non-aggregated soil.

3. Fire-derived carbon: fate and re-distribution by soil animals.

4. Plant root growth and death rates: effects of animal burrows, root herbivores, rhizosphere grazers.

5. Physical structure: casts, mounds and burrows produced by soil ecosystem engineers (including soil fauna and roots) affecting vertical and horizontal organic matter patterns in soil.

6. Deep soil: distribution of old and young C through fauna (accessibility vs. recalcitrance of SOM to microbial attack and C sequestration).

7. Permafrost soils: short- and long-term invasion effects by soil fauna (e.g. enchytraeids and earthworms).

8. Soil microorganisms and faunal activities: gut passage, modification of environmental conditions, and distribution of microbial propagules (promotion of coexistence of different microbial species).

The challenge is to join scattered research activities in nationally funded research projects across COST European countries and create synergy through networking to come up with new frameworks of SOM dynamics and modelling that consider the role of soil fauna. The realism of SOM model concepts and their predictive power would thus be strongly enhanced. In an interdisciplinary approach existing SOM models will be supplemented by sub-models/modules related to soil fauna and address:

(i) Specific aspects of soil fauna (see 1-8 above);

(ii) New insights from recent papers, and field and laboratory studies;

(iii) Research needs.

B.2 Current state of knowledge

Understanding and modelling SOM is essential for managing soil fertility, agricultural productivity and soil ecosystem services like nutrient cycling and carbon sequestration. SOM quantity, quality and stability are controlled not only by the molecular structure but also by environmental and biological controls (Fontaine et al., 2007; Schmidt et al., 2011). Soil animals, their biodiversity and species traits are crucial for SOM turnover (Wardle et al. 2008; Chauvel et al. 2009; Uvarov 2009; Wall et al. 2008). When the ingested SOM is metabolized, its chemical structure is altered (Hedde et al. 2005), e.g. when micro- and mesofauna excrete ammonia or dissolved organic carbon (Osler and Sommerkorn 2007; Filser 2002, Fox et al. 2006). Organo-mineral structures are dominated by biological processes (Lavelle and Spain, 2006; Kögel-Knabner et al., 2008). Soil fauna affect soil structure formation through their burrowing, consumption and excretion activities, significantly enhancing OM incorporation into the soil and macroaggregate formation. Mucilages from fungi, plant roots or animal gut passage can glue materials at the macroaggregate scale in soils. Humic

substances are formed during gut passage: organic matter (OM) in young soils and humic horizons almost completely consists of soil animal faeces.

SOM modelling has thus far largely ignored soil fauna due to various reasons:

(i) hardly existing communication between [C flow centred] biogeochemistry and [organism-centred] soil ecology (different societies, conferences, journals – one of the main reasons for this Action),

(ii) lack of [awareness of] data on soil animals (both in the field and from laboratory experiments),

(iii) soil ecologists have at least two rather different ways to explain processes: food-web vs. self-organization (Barot et al. 2007). Most information sustaining the food-web hypothesis is derived from microcosm experiments that do not or only poorly represent the real conditions of a soil matrix, especially the internal distribution of habitats for small invertebrates.

Soil fauna comprise ecosystem engineers as well as an armada of mobile actors connecting elements of the soil system, mediating microbial processes. Bacteria dominate in terms of biomass, but their composition, activity and distribution is controlled by abiotic factors and the activity of soil fauna. The key players and specific effects vary, with increasing importance at humid-warm and nutrient-limited conditions (Osler and Sommerkorn 2007; Fox et al. 2006; Wardle et al. 2008; De Deyn, 2008). Microbial recolonisation and distribution of fire-derived carbon is also mediated by soil fauna that survived at greater soil depth (Eckmeier et al., 2007).

Countless isopods, ants, enchytraeids, microarthropods, nematodes or protozoans invisibly make large contributions to SOM turnover underground (Osler and Sommerkorn 2007; Filser 2002, Fox et al. 2006; Wardle et al. 2008; Wilkinson et al. 2009). They affect the activity and community composition of soil microorganisms in multiple ways such as feeding, ensuring the coexistence of different fungal species (Crowther et al. 2011), distributing propagules or by modifying environmental conditions. Roots grow preferably in existing soil cavities, mostly formed by soil fauna (Wilkinson et al. 2009).

Changes in climate, land use, resource availability and biotic interactions alter the distribution of soil fauna, activity and associated impact on distribution and turnover rate (Wall et al. 2008) of SOM to the extent that underlying assumptions of SOM models may no longer be valid (Brussaard et al. 2007). Without considering the role of soil animals, models are less predictive. Consequently, there is a current need for a common view and conceptual framework to all soil ecologists to resolve this internal debate. However, also promising approaches exist. For instance, Osler and Sommerkorn (2007) pointed out the relevance of N availability for the C cycle and the important role of soil fauna within that context. This model highlighted gaps in knowledge, not only for effects of soil fauna on processes, but also for understanding of the soil C and N cycle in general.

This C and N cycling processes across land use systems and geographic locations were strongly and consistently predicted by soil food web properties, explaining them better than land use (de Vries et al. 2013). However, in focusing on soil food web models, they disregarded the (quantitatively probably) important activity of soil engineers (Sanders et al. 2014). Moreover, the consequences of the huge bioturbation (in the order of several hundreds of tonnes per ha per year) mainly by large soil ecosystem engineering like earthworms on soil C dynamics should not be neglected (Decaëns et al. 1999; Lavelle and Spain 2006; Wilkinson et al. 2009). Major soil ecosystem engineers create physical domains in soils that have all the characteristics of self-organized systems as defined by Perry (1995): based on strong and rather specific interactions within physical boundaries, these systems change the constraints of their environment with positive feedbacks on their own living conditions (Lavelle and Spain 2006).

Lab experimentation studies have suggested the possibility that soil fauna enhances N_2O emissions from agricultural soils (Lubbers et al., 2013). However, most laboratory studies on GHG emissions involve highly manipulated and simplified meso- and microcosm experiments that do not necessarily represent the real world. The experimental conditions under which they were conducted were often so distant from real field conditions that extrapolating findings to agricultural and other managed soils could lead to erroneous conclusions on the relevance of soil fauna for GHG emissions. Understand and clarify the role of soil fauna in SOM dynamics and provide clues to understand the consequences of changes functional groups composition on gas emissions and other services from different ecosystems is required.

A pillar within this Action is the urgent need to integrate scales: To what extent is upscaling to the field really possible on the basis of microcosm and other laboratory results? Where are the limits of extrapolating small-scale field experiments or monitoring data to larger scales? Are such limits comparable across different, climates, soils or land use systems? The issue of scale has been recognized as very important in addressing soil faunal effects on soil organic matter (Brussaard et al., 2007), but progress seems to be limited (Braakhekke et al., 2011). Although the relationship is not straightforward, the soil environment influences the spatial distribution of soil fauna but also the impact of soil fauna on soil environment can be detected (Jiménez et al., 2012).

B.3 Reasons for the Action

European research groups have contributed significantly to advance the science as well as the experimental protocols within SOM and soil fauna impacts research over the past two decades through national and EU supported research projects. Nonetheless, interactions between SOM and

soil fauna research and modelling require significant attention and a joint effort of the scientific community so as to let experimentalists and modellers closely collaborate and share expertise and data, supported by targeted coordination and appropriate means for communication. This Action will provide a sound framework for such an effort bringing together experiences from the research communities in order to develop new guidelines and conceptual frameworks, educating a new generation of soil ecology experimentalists and modellers and linking significant European research with corresponding research globally.

The Action aims at scientific/technological advancement and will provide immediate benefits to the scientific community by:

- Constructing a significant and transparent network of existing soil organic matter and soil faunal ecology experiments across Europe
- Ensuring close interactions between soil organic matter and soil fauna experimentalists and modellers
- Providing training and education of the next generation of researchers in connecting these fields
- Identifying gaps in knowledge and guiding future research, including also those related to extreme events;
- Providing a strong collaborative counterpart to global research networks.

In summary, this Action will be innovative in addressing the above-mentioned challenges related to the role of soil fauna in SOM dynamics, for more reliable SOM modelling.

B.4 Complementarity with other research programmes

This Action will sustain the effort made, especially in the EU to understand the role of soil biodiversity in SOM dynamics and provide clues to understand the consequences of changes of biodiversity on gas emissions and other ecosystem (dis)services. The Action complements and supports several ongoing activities in Europe. National, EU and JPI research programmes related to SOM and soil fauna focus on specific research projects while at present there are no networks or programmes providing networking across soil fauna – SOM experiments. Also links to SOM modelling are absent.

At the project level, most past and current national funded projects related to SOM dynamics and soil fauna in participating countries will be directly involved in this Action as a platform for

discussion, forum, experience exchange, development of new ideas and international networking and exchange. In addition, the Action will provide a network to continue and exploit experience developed in previous EU-FP6, FP7, other international and selected national projects like SoilService, Ecofinders, Edaphobase, Macrofauna, each of them with large datasets available. Furthermore the Action will provide a significant platform for Early Stage Researchers (ESR). Finally, the Action is expected to complement research actions developed under EU Horizon 2020.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The aim of the Action is to specifically, implement the role of soil fauna into existing SOM models for land use and natural resource management. Based on this a set of recommended agricultural practices for reducing depletion of SOM will be launched. This ambitious goal will be achieved by bringing together a community of soil experimentalist researchers and soil fauna specialists with demonstrated experience in designing and conducting SOM experiments, and by deriving how the experimental impacts of SOM and soil fauna manipulation can be measured and modelled. The Action will (1) identify knowledge gaps in existing data and SOM models, ii) establish the role of the soil fauna in SOM turnover from local (land use and disturbance) to global scales (geology, climate), iii) share and compile information from the different projects at the national level, and iv) provide training for young scientists. This Action will have a highly multidisciplinary profile, including areas like plant-, soil- and community ecology, microbiology, biogeochemistry, modelling and data management. It will thus provide comprehensive view on how the soil fauna-SOM interaction impacts on ecosystem processes in terrestrial ecosystems, including guidelines of how they should be studied. SOM-soil fauna interaction research is particularly challenged with the complexity the multivariate drivers and non-linear responses of the processes under study. This Action will deliver scientific syntheses of the current understanding of soil fauna-SOM interactions, identify gaps in knowledge and provide guidelines for future experimentation. Moreover, the Action will address the key scientific challenges and produce guidelines for improved data and meta data management and better linkages between experimentalists and modellers.

C.2 Objectives

The Action has three main objectives:

i) to develop quantitative and regionally explicit parameters that adequately depict the role of soil fauna in SOM dynamics;
ii) to create an extensive network between soil scientists of various disciplines, and the setup of common experimentation;
iii) to relate SOM model parameters to empirical observations from experiments and current projects across Europe.

The expected goals of this COST Action are:
1. To establish a network of soil ecologists, biogeochemists and modellers for collecting scattered information from current experiments and projects on the role of soil fauna and C dynamics.
2. To develop a common conceptual framework for modellers and empiricists, involving experts in biogeosciences, soil ecology, SOM turnover, N dynamics, and modelling;
3. To scrutinize different approaches for implementing the role of soil fauna in SOM dynamics for a better integrated soil fertility and land use management.
4. To improve decision-making support to ensure effective policy at local, regional and international level regarding land use, soil fertility and GHG emissions.

The benefits from this Action are i) at the scientific level, by in-depth data analysis of parameterized variables for improved and more realistic modelling of SOM dynamics, and ii) at societal level, benefits are expected by providing recommendations for land management across regions and countries. This way, preservation of SOM, conservation of soil fauna and soil fertility are optimized.

C.3 How networking within the Action will yield the objectives?

The Action will achieve its objectives by:
- Creating a multidisciplinary network of experimental and modelling scientists in order to promote a new generation of experiments and modelling in parameterizing soil fauna activity and SOM dynamics.
- Organising topical and cross disciplinary workshops involving relevant scientists in SOM and soil fauna experiments and modelling.
- Organising Training Schools specifically targeted towards training of ESR related to both scientific and technical aspects of climate change experiments.
- Establishing a Forum of Young Researchers (FYR) providing a network for young scientists. The

potential to organise small topical FYR workshops will be explored.
- Supporting Short Term Scientific Missions (STSM) particularly for ESR to visit participating research institutions within the network.
- Organising two international conferences focusing on the outputs of the Action and specifically one in collaboration with other international agencies and networks.

C.4 Potential impact of the Action

The Action will be scientifically innovative and have potential impacts on:

Scientific integration and visibility of European experimental research:
The Action will establish close collaboration with international research networks thereby improving the visibility of European research communities in the field.

Data sharing: Existing databases from SOM manipulation experiments and soil fauna are difficult to access. One of the objectives of the Action will be to deliver a meta-database to improve the overview of experiments, data and models to date and produce guidelines and protocols on core measurements to increase the use of experimental results, data base development and improved data access for modellers (password protected).

Up scaling of results: The Action will increase the awareness and understanding of the scale issue in field experimentation and how to achieve an improved understanding of how well relatively small and short lasting experiments can be scaled to larger spatial units and extrapolated in time. Special focus will be given to spatial patterns of processes under study, e.g. soil fauna and soil C emissions.

High level scientific position papers: The Action will produce 4 perspectives papers outlining state of the art and proposing future research needs within its overall area and the four specific objectives.

Improved use of facilities: The Action will support STSMs and transnational access to research facilities by other scientists, especially by ESR.

Education of a new generation of scientists in SOM – soil fauna interaction experiments:

The Action will provide training for young scientists through workshops, Short-Term Scientific Missions, Training Schools and a Forum of Young Researchers (FYR).

C.5 Target groups/end users

The results of this Action are key to support the EU and international initiatives to monitoring, quantifying, understanding and managing soil biodiversity and associated ecosystem services. The strongest direct interest in the activities of the Action will be from the scientific community participating in nationally-funded projects across Europe, and also from current and past specific EU projects like Edaphobase, Ecofinders, Macrofauna, and others.

Indirectly, this Action will be of interest and relevant for both national and international policy makers. Besides, other policy oriented organisations with a focus on Natural Resource Management and ecosystem services supported by terrestrial ecosystems would be interested in this Action.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action is organised in four Working Groups (WGs) that build upon each other to develop a global framework.

WG 1 – Network: sharing data and information, state-of-the-art and gap analysis of SOM – soil fauna interactions; minimum data set compilation for each of the eight biogeochemical aspects; datasets from different EU-FP6 and FP7 projects will be used, as indicated in section B4.

WG 2 – Review and evaluation of existing global SOM models and analysis of their potentials and limitations for inclusion of soil fauna effects; development of soil fauna-related sub models and implementation into global models of SOM dynamics; the development of the conceptual model is the goal for WG 2.

WG 3 – Assembling data from the different sites in a database as basis for extensive analyses; the

network is expected to continue for future analyses after the end date;

WG 4 – Dissemination of results from analyses, knowledge management and material for training and stakeholder purposes.

Implement the effects of soil fauna in the models is challenging but starting with a COST Action is certainly the most promising approach.

This Action will be based in four tasks:
• Task 1: state-of-the-art and gap analysis of SOM – soil fauna interactions data
• Task 2: Review and evaluation of existing global SOM models
• Task 3: Assembling data and meta data
• Task 4: Dissemination of results from analyses, knowledge management and material for training and stakeholder purposes

The scientific focus of the Action will be to identify and guide how SOM models can better incorporate the activity of soil fauna in order to improve understanding of the processes governing SOM dynamics in which soil fauna participates. This will be essential for managing soil fertility, agricultural productivity and soil ecosystem services. This will help address the most prominent challenges for society in the future of climate change. This Action will have potential impact on future soil C emission modelling. The scientific focus will be directed to stronger and more efficient integration of ecosystem models into soil fauna experiments. Which are the best experiments to address the key issues needed for a more comprehensive modelling of SOM and soil fauna. Methodologies, potential drawbacks, statistical designs, relevant response measurements, multifactor approaches, and non-linear relationships will be addressed in the Action.

This can be a traditional use of models for evaluating results or up-scaling and out-scaling results, but can also be using models more consistently in the design of experiments to generate hypotheses or fine-tuning scenarios to apply. Such enhanced use of models requires better data and also better data access.

D.2 Scientific work plan – methods and means

The Action will be based on 4 Working Groups following the 4 tasks described above:

WG 1 – Network: sharing data and information, state-of-the-art and gap analysis of SOM – soil fauna interactions

The objective of WG1 is to review the "state of the art" of SOM and soil fauna interactions. One subtask of the WG1 will address the challenge of providing open information on experiments to facilitate sharing of data and results for general synthesis, meta analyses and modelling; The understanding will require a new conceptual framework and new experimental approaches for minimum data set compilation for each of the eight biogeochemical aspects. The past experimental results with different hypotheses linked to soil fauna activities will be reinterpreted. A network approach like COST will be particularly relevant for this type of development because no individual experiment will cover the issues alone. Another subtask will be to analyse how all the aspects considered can be most efficiently addressed by experimentation.

WG1 will organise annual topical workshops related to the overall task. In order to assure close integration of the existing global SOM models, data and modelling, one workshop will be jointly organised with WG2, and another one with WG3.

One TrainingSchool will be held at a relevant site with field scale experiments in order to address key issues of experimental design, scenarios, and artefacts.

WG 2 – Review and evaluation of existing global SOM models

The objective of WG2 will be to review and analyse existing global SOM models and to analyse their potentials and limitations for inclusion of soil fauna effects. One subtask will be the development of soil fauna-related sub models and implementation into global models of SOM dynamics, and to analyse the major limitations, such as lack of coherent complementary site conditions (e.g. soils), multifactor issues and replication, and spatial and biotic interaction processes. Improved integration of experiments, especially in the field and modelling will be sought. WG2 will organise annual topical workshops related to the overall task. At least one of these will be jointly organised with WG1 and another one with WG3.

A subtask will analyse how well SOM models like CENTURY can address the contribution of soil fauna when modifying different parameters like bulk density, tillage, crop rotation, etc.

WG 3 – Assembling data and meta-data

The objective of WG3 will be to address the challenge of providing open-access data and information from the different projects and sites in a database as basis for extensive analyses, general synthesis and modelling. A focus on both the short- and long-term contribution of soil fauna to all aspects of SOM dynamics will be part of another subtask within the WG3. Another subtask will be to identify the needs and most useful means to promote data sharing and identify current obstacles and needed promotions. Strategies for promotion of data sharing facilities based on databases or web or cloud based data sharing "hubs" will be outlined and implemented within this subtask.

WG3 will further interact and engage in workshops from all other WGs to assure that the data sharing issue is an integrated part of the experimental and modelling discussions. A workshop inviting relevant experimentalists and data managers from major national and European framework projects to discuss and propose solutions to data sharing issues will be organized by WG3.

The network is expected to continue for future analyses after the end date;

WG 4 – Dissemination of results from analyses, knowledge management and material for training and stakeholder purposes.

The objective of WG4 will be to outline strategies between soil fauna experiments, field experiments and SOM modelling. A subtask will analyse how well models can address extreme events such as long-term droughts, heat waves, flooding or drought promoted fires, including both short- and long-term impacts of the extreme events.

WG4 will organise workshops aiming to produce a position paper for each task described above and will organize a Training School directed to integrating models and field experimentation. WG4 will also offer training sites as part of the short-term mission program.

An interactive website will be launched and continuously updated providing information on activities, key finding, document repository, data sharing platform and information from other relevant activities. Searchable information of experiments, gradients and models related to SOM

dynamics and soil fauna activity (information of study sites, experimental characteristics, methods, response measurements, model-data integration, data availability, publications, and contacts) will be included in a Meta-database (password protected)

Electronic handbook guideline – this will include methods, modelling protocols and the minimum data set needed in modelling SOM dynamics and soil fauna activity.

Reports – with major achievements for decision makers and stakeholders at local, regional and country levels, will be provided electronically.

Two international conferences organised in collaboration with other international networks. One will include societal stakeholders such as research managers and policy makers.

Annual workshops on WG specific topics for a smaller audience, eventually in relation to annual conferences (4 workshops minimum).

Training Schools – on experimentation, analytical tools and modelling. The Training Schools will be targeted specifically at ESR and will combine theoretical and “hands on” experiences (at least 2-3).

Short Term Scientific Missions – Each WG will provide announcements of STSMs. Priority will be on STSMs for data analysis and interpretation for Early Stage Researchers (ESR) related to the development of the Action area and with publication potential (>10 STSM).

E. ORGANISATION

E.1 Coordination and organisation

Organisation and management - The organisation and management of the Action will consist of the following entities:
Management Committee (MC): The MC will be responsible for the overall coordination of the Action through annual meetings and regular contacts with WG Leaderss.
Working groups (WG): Four WGs will form the basis of the Action. A WG Leader and Vice Leader will be responsible for the WG specific activities such as workshops, Training Schools

and Short Term Scientific Missions.

Short Term Scientific Mission panel (STSM): The Action is determined to strongly promote training of young researcher for example through STSM support. The STSM panel will include a delegate from each WG and will manage and evaluate STSM applications. An STSM Coordinator will be elected.

Forum for young researchers (FYR): An informal forum of young researchers will be formed based on the ESR participants and in the Action and the Training Schools. A leader will be nominated by the FYR.

Meetings and communication - a number of meetings and communication activities will be organised to ensure the activities and the networking. These are:

- *Workshops:* The Action will organise two sets of workshops.

1) Annual international workshops (hosted by participants in the Action) bringing together a wide community of research scientists to present the "state of the art" and outline future research needs related to the COST Action area.

2) Smaller (15-30 people) WG specific topical workshops targeted at the deliverables of the WG. At least 10-20% of ESR participation will be obligatory in all workshops. The WG workshops will be encouraged to produce a high level position paper as an outcome of each workshop.

- *MC meetings:* Each year the MC will meet separately to discuss and decide the progress of the Action, WGs, deliverables and future activities. The MC will specifically discuss potential collaborators and actions that each MC member should take forward to engage to guarantee the transfer of knowledge at national level, e.g. in relation to annual workshops.

- *Steering Committee (SC) tele-meetings:* These meetings will be held 4 times a year to discuss progress and on-going matters.

- *Website:* The Action will establish a website to inform about its activities as well as activities elsewhere of relevance to participating members (meetings, conferences, Training Schools, publications, etc.). The MC will consider the establishment of the Action profile in social networks like Facebook and/or Twitter to keep a continuous dialogue with interested parties.

Milestones - the progress of the Action will be assured through observing the following milestones:

- *First MC meeting:* The first MC meeting at the beginning of the Action, which will involve agreeing on the constituency of the MC and SC, the Election of the Chair, Vice-Chair, Working Group (WG) Leaders, YSF Leader and STSM panel.

- *Website:* The interactive Website for the Action will provide information on the Action's networking activities.

- *Annual workshops:* A rough plan for annual Action workshops (including MC and SC meetings) as well as WG workshops will be outlined at the first MC meeting. Annual workshop will be outlined one year ahead, including election of an organizing committee. The topical WG workshops will be suggested to the MC for approval 6 months in advance.

- *Training Schools:* Grand plans for Training Schools (content, venue, size, budget) must be presented for discussion and decisions by the MC at the 2nd annual workshop.

- *Position papers:* Plans for position papers and responsible lead authors will be decided at the 2nd annual workshop based on proposals from each WG.

- *Conferences:* A grand plan for international conferences organized by the Action and collaborators will be outlined at the first MC meeting and decided in more detail at the 2nd annual meeting.

E.2 Working Groups

The Action will establish four Working Groups (WG) to focus on each of the four tasks:
WG1 – Network: sharing data and information, state-of-the-art and gap analysis of SOM – soil fauna interactions
WG2 – Review and evaluation of existing global SOM models and analysis of their potentials and limitations for inclusion of soil fauna effects
WG 3 – Assembling data from the different sites in a database as basis for extensive analyses

WG 4 – Dissemination of results from analyses, knowledge management and material for training and stakeholder purposes.
The WGs will plan topical workshops, Training Schools and STSMs within their area and in collaboration with other WGs. In order to assure coordination and maximum outcome major activities will be submitted to the MC for discussion and approval. For each WG a number of subtasks will be agreed in order to better ensure the implementation of the work plan and to achieve the objectives of the Action.

E.3 Liaison and interaction with other research programmes

This Action can involve collaboration and linkages for information sharing and exchange with the on-going TD1107 COST Action: Biochar as option for sustainable resource management. The Action will directly involve scientists from on-going and past projects within EU framework programmes FP5-7.
Within the specific framework of Horizon 2020 significant potentials for collaboration will be a specific task for MC to evolve. Potentials for collaboration, for example through joint involvement of researchers or organisation of joint meetings will be on the agenda for the MC.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve Early-Stage Researchers (ESR). This item will also be placed as a standard item on all MC agendas.
In order to guarantee the gender balance, two of the WGs will be led by women and two by men and mixed gender representation in all activities will be ensured.
Each WG should have a Leaders or Vice Leader being a woman (“feasible” meaning, i.e. if no women with relevant skills are available, the WG will be activated with a man instead.)
As described above, a significant part of the budget of the Action will be reserved for ESR through required ESR participation in workshops and through funding STSMs and Training Schools, where ESR will have a priority. It is established as a rule that for each WG the Leader or the Vice Leader should be an ESR. The Action will include a Forum of Young Researchers to encourage and ensure stronger ESR representation.

F. TIMETABLE

The Action will last four years. Table 1 below shows a timetable of main activities:

	Year 1 Month 1-6	Year 1 Month 6-12	Year 2 Month 1-6	Year 2 Month 6-12	Year 3 Month 1-6	Year 3 Month 6-12	Year 4 Month 1-6	Year 4 Month 6-12
First MC meeting and internal midterm assessment	X			X				
Website	X	X	X	X	X	X	X	X
MC meeting	X		X		X		X	X
Teleconference / Scientific meetings	XX	XX	XX	XX	XX	XX	XX	XX
Intl. conference				X				X
WG – workshops	X	X	X	X	X	X	X	X
STSM		X	X	X	X	X	X	X
Training Schools				X		X		
FYR meeting			X		X		X	
Papers		X		X		X		X

MC: Management Committee; SC: Steering Committee; FYR: Forum of Young Researchers.

MC meetings will occur typically at the beginning of each year.

One main conference will be organised by the end of 2nd year or early 3rd year, and a second major conference at the end of the Action with the primary purpose of transferring knowledge and launching new initiatives emerging from the Action.

The timing of the STSMs (two calls will be launched every year) and Training Schools (three will be organised – one each in the second, third and fourth years) will be decided by the WGs.

The activities of the different WGs will start immediately after the first MC Meeting.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, CZ, DE, ES, FR, IE, NL. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 28 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The target audiences for the dissemination of the results of the Action are:

Scientific communities

It is evident that the topic of the Action will be mostly of direct relevance to the scientific community involved with climate change experiments and measuring and modelling the responses. Networking and the recommendations and guidelines will be directly relevant for future experiments. Also scientific communities establishing and providing research infrastructures and private companies engaging with experimental infrastructures and technical aspects of experimentation will be a relevant audience. Finally, ESR will benefit strongly in their development from the workshops and especially the STSMs.

International and national research managers

New national and international research programmes will benefit from the recommendations and guidelines provided by this Action to address key scientific challenges by the most relevant approaches.

Policy makers:

Societal bodies responsible for actions to adapt or mitigate to ongoing climate change will have an indirect interest in the results provided by the Action since the Action will provide improved guidelines for experiments, modelling and up scaling of results.

H.2 What?

The dissemination of the Action will be carried out through:

Web site

This will be created to provide information and host the main outputs of the Action including

references to main guidelines and information about activities, workshops, STSMs, etc. developed within the Action.

Training

Training is a major focus of this Action. Short-Term Scientific Missions (STSMs) will be offered to young scientists and scientists from developing regions. STSMs will facilitate knowledge transfer and training in new techniques or shared use of critical equipment or field sites. Training Schools (TS) for post-graduate students are also envisaged.

Training workshops

Topical workshops will enable the dialogue between various scientific communities, especially among experimentalists and modellers. These may be in association with the annual workshops to save resources for STSMs.

Meetings

A major international conference on “Status and challenges in soil fauna and SOM experiments and modelling under climate change” or similar title will be held in collaboration with other international networks.

A large final conference will disseminate all the main findings and achievements of the Action to all target audiences – including a session targeted at Young scientists and a session targeting “societal benefits from experiments”.

TheAction Chair who will be elected at the first MC meeting will chair the Action in collaboration with the Vice-Chair of Action Management Committee (MC) that involves all participating countries in the Action, and with one team leader for each Working Group (WG). The core of activities will be carried out at the WG level with at least one annual meeting per WG to coordinate activities with scientists and actions for specific tasks and for knowledge management and dissemination.

Short-Term Scientific Missions (STSM)

STSM will contribute to the scientific objective of the Action by fostering and strengthening networking aspects. Young scientists active in SOM research and experimentation will be attracted, and networking activities will be reinforced through STSM for ESR. Scientists are allowed in the STSM to go to another laboratory and institutions in COST countries to promote collaboration, to learn new techniques, either theoretical or experimental, and access to new equipment and tools in SOM studies. A coordinator for STSM is appointed by the MC and a STSM training committee will be established. Scientific and budgetary assessment will be made by STSM training committee and final decision will be communicated by the STSM Coordinator.

Publications

Five papers (peer reviewed), one perspective paper for the Action and one for each WG, which will be mainly disseminated to the scientific community, focusing on gaps in knowledge and recommendations for future research. Guidelines / Manuals for research and modelling, will be developed and mainly disseminated to experimental communities.

H.3 How?

The MC will specifically develop a detailed dissemination plan as part of the first MC meeting and will adapt it throughout the Action to meet identified needs and priorities. Total visits to the website, number of applications to the STSM calls and Training Schools, and number of requests from people outside the MC to join the WGs, will give an indication of dissemination efficiency and will suggest actions to be undertaken to improve it throughout the Action.

All activities of the Action, such as announcements for workshops, conferences, publications, STSMs, and Training Schools, will be advertised through the website.

Moreover, mailing lists provided by participants targeting European and national projects/networks/associations, will be used to further disseminate of information to a wider range of end-users. Materials and/or minutes from the Workshops, Conference and Training Schools will be made available through the website.