



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

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Secretariat

COST 259/08

MEMORANDUM OF UNDERSTANDING

Subject : Memorandum of Understanding for the implementation of a European Concerted Research Action designated as Cost Action FP0803: Belowground carbon turnover in European forests

Delegations will find attached the Memorandum of Understanding for COST Action FP0803 as approved by the COST Committee of Senior Officials (CSO) at its 172nd meeting on 24-25 November 2008.

MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action FP0803

BELOWGROUND CARBON TURNOVER IN EUROPEAN FORESTS

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 270/07 “Rules and Procedures for Implementing COST Actions”, or in any new document amending or replacing it, the contents of which the Parties are fully aware of.
2. The main objective of the Action is to improve and to coordinate the methods and the knowledge to measure and calculate belowground carbon (C) turnover rates, and to implement the obtained values in improved biogeochemical models to develop sustainable belowground C management strategies for European forest ecosystems to ensure a maximum of resilience under adverse or gradually changing environmental conditions.
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 104 million in 2008 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 Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

The importance of belowground carbon (C) turnover in the functioning of forest ecosystems is often underestimated. While inputs and outputs of C in the aboveground part of forest ecosystems can be measured relatively easily and continuously, little is known about the mechanisms and processes of belowground C allocation. These include processes affecting the turnover rates of fine roots, mycorrhizal fungi, and soil organic matter. This Action aims to harmonise and improve knowledge on the benefits provided by belowground C processes. The Action will focus on the four key areas: fine root turnover, mycorrhizal mycelia turnover, soil C stocks, and biogeochemical modelling, with the intention of linking the different research fields involved, evaluating the potential of new and innovative methodologies, and developing new process-based descriptions of belowground C dynamics within biogeochemical models. This is important as the projections of C dynamics in forest ecosystems under changes in climate and atmospheric CO₂ concentrations need to be improved, and most European countries need to assess changes of belowground C stocks in forests under the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

Keywords: belowground carbon dynamics, biogeochemical modelling, fine root and mycorrhizal mycelia turnover, forest soils, soil organic matter

B. BACKGROUND

B.1 General background

It has only recently been recognized that biological processes can control and steer the Earth system in a globally significant way. Terrestrial ecosystem release or absorb globally relevant greenhouse gases e.g. carbon dioxide (CO₂) and, because ecosystems themselves are subjected to local climatic conditions, a multitude of climate-ecosystem feedback potentially amplifies or dampens regional and global climate change. In particular, feedback between the C cycle and the climate has recently received much attention, mainly because the atmospheric concentration of CO₂ is predicted to reach

double its current levels by 2075. Over 75% of the C in terrestrial ecosystems is stored in forests, with more than half of this C being in soil organic matter (SOM), which has the potential to sequester the largest amount of C for the longest period of time. Therefore, liberation of belowground C into the atmosphere as CO₂ or CH₄ (methane) has the potential to seriously affect the global climate. Because future climate scenarios predict that large parts of Europe will experience an increase in dry, warm summers, and an increase in extreme events, there is concern that the rate of increase in atmospheric concentrations of CO₂ over the coming decades will accelerate.

While inputs and outputs of C in the aboveground part of forest ecosystems can be recorded relatively easily and continuously with measuring the relevant C-containing gases, the belowground C processes involved, in particular the dynamics of soil C stocks, are neither easy to monitor nor well investigated and understood,. Soil C accumulation and release are controlled by biomass inputs, rates of decomposition, and stabilization, and for soil C stock accumulation, the belowground biomass inputs from fine roots and mycorrhizal fungal hyphae are as important as the aboveground inputs from leaves and needles.

The belowground C inputs are comparatively poorly represented in models of soil C dynamics and in large-scale biogeochemical models (BGMs). Sensitivity analysis of terrestrial biosphere models have revealed that modelled changes in terrestrial C storage are highly dependent on process representation and model parameterisation, in particular the response of soil C pools to climate change. Improving model representations of C fluxes is therefore crucial for reliable projections of climate change.

There is already a large amount of data about belowground C in forests. However, this data needs to be harmonized and methods for winning the data calibrated and compared. However, these data are dispersed across Europe and require a large network to be of relevance. There is also still considerable inconsistency in the methods used. In parameterisation of models, model constructors are often unaware of the background, as well as the strengths and weaknesses of the data used. This data requires extensive collaboration between data providers and modellers. Only COST can

provide this framework. All other funding bodies either have major interests only in provision of new data, or do not provide depth of continuity as that provided by COST. Examples of this are: 1) Some of the scientist that have actively contributed to this submission previously worked on a FP7 proposal, however, the FP7 proposal is about new data acquisition, and does not allow for wide European participation; 2) A single meeting support by ESF is insufficient for the needs of this project. This project requires a series of meetings with adequate thinking time between the meetings, as well as building a basis of trust and co-operation between the participants.

The major advantages of developing this project within the COST framework are related to the following points:

- The full understanding of the complexity of the belowground C cycle is depressed by the lack of communication between the different fields of research involved. As an example: soil scientists mainly work on SOM pools in soil horizons, but this sampling strategy do not always fit with those of scientists studying root turnover, and no data match is possible. The COST framework is the best opportunity to put together scientists from different research fields.
- Many scientific papers have been published in the last decade, providing an apparently huge amount of data on several kinds of forest ecosystems. These results are, however, hardly usable because of the lack of harmonization in methods and in pool definitions. A COST Action aimed at the full understanding of the mechanisms which govern the belowground C cycle will make these previous results more comparable and of real use.
- Only very few experimental sites are equipped for the study of the effects of increased CO₂ on forest ecosystems, or with other high cost and innovative instrumental facilities. These sites provide a precise, although site-specific, response and help in the investigation of the mechanisms of belowground C cycle. There is a need for data extrapolation to cover a more extensive range of environments, starting from site-conditions and mechanisms. This can be reached only through a COST Action.

- Some situations which are currently present in forest ecosystems of Southern Europe may provide data inputs for changing scenarios in other parts of Europe. This is possible only if experts from different parts of Europe contribute to the discussion.
- The topic has a truly international dimension, as the changing climatic conditions will affect forest ecosystems all over Europe, and as most European countries need to assess changes of belowground C stocks in forests under the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

B.2 Current state of knowledge

The highly simplified representations of soil C dynamics used in generalized, large-scale BGMs sharply contrast recent findings about the complex controls of soil C dynamics. For example, C inputs occur through litterfall, plant mortality and fine root turnover, but root turnover rates are highly uncertain and a number of processes are neglected in the BGMs, in particular the C input through hyphae of mycorrhizal symbionts and the effects of increasing CO₂ concentrations and elevated temperatures. Therefore, these uncertainties are likely to severely limit our ability to make reliable predictions of how climate change will impact on ecosystem functioning.

Although the fine roots (<2 mm in diameter) of forest trees contribute less than 2% of tree biomass in mature forests (appr. 6-8 t/ha in temperate and boreal forests), they contribute largely to the belowground C stocks as they are short-lived organs with life expectancy from weeks to several years and a rapid turnover. This, however, is depending on species and environmental conditions, and on the applied methods. The yearly contribution of the fine roots to the belowground C pools is assumed with 1 t/ha.yr to be about equal to the yearly leaf or needle input. The methods to estimate fine root turnover include sequential coring, ingrowth-cores, minirhizotrons, or C isotopes, with no standardized methods established. All these methods have biases leading to over or under estimates.

Fine roots of trees are always also associated with mycorrhiza fungi, and approximately 20-30% of current assimilates are allocated to these mycorrhizal fungi. Fungal mantles and extramatrical mycelia of these mycorrhizal fungi are estimated to have a biomass of about 0.5-0.7 t/ha. It is further assumed that at least 30% of the microbial biomass and 80% of the fungal biomass belong to the extraradical hyphae of the mycorrhizal fungi. Very little is known about the turnover of the hyphae, and the few results available reported contradictory results. A fast turnover of 5-6 days was found for hyphae of arbuscular mycorrhizas using ¹⁴C-pulse labelling, while in another study most of the ¹³C label remained in the external mycelia for 32 days after the labelling. However, using ¹³C techniques, mycorrhizal mycelia turnover was shown to be a dominant process for C input into soil C stocks, contributing more than 60% of new soil C.

The largest C pool in forest soils is the SOM. The main changes in the soil C stock are due to the input of remains of fine roots, mycorrhizal hyphae, leaf and needle litter and the loss of C through respiration or leaching of dissolved organic carbon (DOC). The residence time of SOM is determined by where the organic matter entered the soil system and by SOM stabilization processes that may occur. Several main groups of relevant processes occur that protect SOM from decomposition, e.g. physical protection (encapsulation by soil particles or aggregates thereby forming a physical barrier between microbes and their substrate), chemical protection (formation of specific bonds of SOM with colloids or clays), or biochemical protection (formation of recalcitrant SOM compounds). The relative importance of these processes, and thus the proportion of the different SOM pools, is related to the chemical composition of organic matter entering the soil, and to the abiotic and biotic characteristics of the soil itself. Many techniques have been used to fractionate SOM into pools and the results they provide are not always comparable. The chemical fractionation according to the acid solubility of SOM pools was popular in the last decades, and many results are still obtained using this technique, especially when the object of the study is the leaching of organic matter. However, the stabilization of organic matter is more easily followed when a physical fractionation is applied, and SOM is subdivided on the basis of its interactions with

the soil mineral fraction. Some other studies avoid the use of fractionation and directly characterize SOM, inferring therefore information about its stability and turnover from the presence of groups of organic compounds. The gaseous losses of C from the soil are seldom studied in field conditions; often kinetic parameters are obtained in laboratory experiments, and are therefore not easily transferred to real forest ecosystems. As a consequence of this lack of homogeneity, the processes that influence transformation and stabilization of SOM and, therefore, the turnover times of soil C stocks, are still not well known.

With attention focused by the Kyoto Protocol, there has been an increasing need to define present and future C budgets and fluxes at regional and continental scales. Thus, estimates about belowground C budgets and fluxes are supported by BGMs. However, most models ignore the contribution made by fine roots and by mycorrhizal hyphae. This is mainly due to lack of suitable data and understanding of the biology of semi-natural ecosystems. Some improved BGMs, such as Biome-BGC, LPJ-GUESS and GOTILWA, have implemented the contribution of fine roots with given fixed turnover rates, e.g. 1.0 /yr for deciduous and 0.5 /yr for coniferous trees. Other models, such as RothC, CENTURY, or Yasso have split up the SOM reservoir in distinct pools based on their residence times. Still, these SOM turnover models are not fully process oriented and thus the simulation of ecosystem response to environmental changes is still difficult. To improve these models there is a need to link conceptual model pools to functional SOM fractions that are given by defined stabilization mechanisms.

B.3 Reasons for the Action

In a short term, harmonization and agreement on belowground C turnover rates can improve BGMs which already include fine root turnover data. Since the fine root turnover data in these models in general are only "assumed" values, the application of "real" data would improve the models and deliver more accurate outcomes. In a long term, new model parameters should be included into the models which take care of the up to now overlooked C contributions to soil, e.g. that of mycorrhizal mycelia or of specific pools of the SOM. As all the elements of the belowground C cycle are deeply affected by forest management, this Action will provide an indirect benefit by stressing the scientific bases for future management strategies.

Benefits and applications of this Action include:

- Increased scientific knowledge to assess the belowground C pools and fluxes by measuring turnover rates for fine roots, mycorrhizal mycelia, and soil C stocks, for the various tree species and forest types.
- Transferring the knowledge to models, forest managers, stakeholders, and national governments.
- Sharing of this knowledge across Europe, in particular by integrating countries from Southern and Northern Europe.

The Action is aimed mainly at the scientific/technological advance, e.g. evaluation of best BGMs to predict forest ecosystems belowground C pools and fluxes. However, an economic/societal dimension is obvious since the outcomes of the models have impact on future forest management strategies concerning the management of belowground C pools and fluxes.

B.4 Complementarity with other research programmes

At March 1st 2008, a project had been submitted by a consortium of European researchers with the title "TerraC - Impact of climate variability and increased atmospheric CO₂ concentration on belowground ecosystem C dynamics" within the framework FP 7, ENV 1.1.3.1 "Impacts of climate variability, extreme events and increasing atmospheric greenhouse gas concentrations on terrestrial carbon storage, exchange flows and soil carbon dynamics".

In this project the impacts of climate variability and extreme events on C storage, exchange flow and perturbations of soil functioning will be better quantified, by evaluating the until now poorly estimated belowground C fluxes, and by the use of new model developments to scale them to the regional and continental scale. In this project, the turnover rates of fine roots and mycorrhizal hyphae will be determined in various experiments at various fully equipped experimental forest sites throughout Europe. Therefore, one of Europe's few sites will be used which applies field scale elevation of atmospheric CO₂, combined with advanced C isotope techniques to quantify the effects

of increasing atmospheric greenhouse gases on C flow through plants and soil systems. In addition, one of Europe's premier forest drought manipulation sites combined with advanced C isotope techniques will be included to provide new data.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The main objective of the Action is to improve and to coordinate the methods and the knowledge to measure and calculate belowground C turnover rates, and to implement the obtained values in improved biogeochemical models to develop sustainable belowground C management strategies for European forest ecosystems to ensure a maximum of resilience under adverse or gradually changing environmental conditions.

C.2 Secondary objectives

The short-term expected result is to increase the scientific basis for estimating belowground C turnover rates, in particular for fine roots of trees, of which currently only "assumed" values are applied in biogeochemical models. The long-term expected result is that new model parameters could be introduced into the models which otherwise would overlook relevant C contributions to forest soils, e.g. that of mycorrhizal mycelia. By providing a better understanding of the mechanisms governing SOM pools, the Action will allow a scientific link with available soil databases. If the abiotic conditions governing the relative proportion of SOM pools are well known, preliminary information on forest areas not covered by detailed studies can be extrapolated from the knowledge of soil types and climatic conditions.

C.3 How will the objectives be achieved?

The objectives of this Action will be achieved mainly through the participants of the COST Action by:

- Reviewing and summarizing the current scientific knowledge on belowground C turnover in European forests, by creating Working Groups, promoting Short-Term Scientific Missions, compiling databases, and holding one Working Group meeting every year.
 - Transferring this knowledge into methodological and technical recommendations, by producing thematic reports, and elaborating state-of-the-art reviews on belowground C turnover. The latter could be developed as an open on-line working database.
 - Disseminating the knowledge to researchers and modellers, by organizing two training schools, one for researchers to learn about belowground C turnover measurements, and one for knowledge transfer to modellers, to implement the "real" values into improved biogeochemical models.
- Furthermore, several review publications and one major conference will also strongly contribute to disseminate the outcome of this Action.

C.4 Benefits of the Action

The expected benefits of the Action include:

- The improvement of understanding and knowledge about belowground C pools and fluxes in European forest ecosystems.
- The identification of key belowground processes which will change under future climates, and which will lead to more accurate quantification of the impacts of climate variability, extreme events and increasing atmospheric greenhouse gas concentrations.
- The harmonization of methods which quantify better the turnover rates for improved biogeochemical models on a regional and continental scale.
- The improved communication and cooperation between researchers of different scientific backgrounds and areas of interest.
- The occasion to jointly write scientific papers and reviews.
- The initiation of future research or monitoring projects.

- The organization of a continuous improvement process which could exceed the duration of such an Action.

C.5 Target groups/end users

The main end users are:

- Researchers and modellers who investigate forest ecosystems and who apply biogeochemical models.
- Forest managers who are responsible for a sustainable management of the belowground C pools in European forest.
- National governments, who have to report on the C budgets of their countries due to the Kyoto Protocol.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The objectives of the Action will be achieved through four tasks which cover all relevant topics:

- Gathering knowledge about fine root turnover rates.
- Gathering knowledge about mycorrhizal mycelia biomass and turnover rates.
- Gathering knowledge about soil C stocks and turnover rates.
- Transferring the knowledge to modellers which apply biogeochemical models.

Other tasks may be created to accommodate disciplinary perspectives and activities not foreseen during the preparation of the proposal.

D.2 Scientific work plan – methods and means

The work plan is divided into four Working Groups (WGs):

- WG1: Fine root turnover.
- WG2: Mycorrhizal mycelia biomass and turnover.
- WG3: Soil C stocks and turnover.
- WG4: Biogeochemical modelling.

Objectives and achievements of the WGs are:

WG1: The tasks of WG1 are mainly the gathering of knowledge, discussion, and giving common agreements on fine root turnover rates:

- Collecting and itemizing the literature on methods and calculation formulas to estimate fine root biomass, production, mortality, lifespan, decomposition, and turnover rates, e.g. sequential coring, ingrowth cores, mesh bags, min-max. method, minirhizotrones, ^{13}C and ^{14}C isotopes, a.o.
- Comparing and evaluating the current methods for fine root turnover estimations and calculations, summarizing the advantages / disadvantages and strengths / weaknesses of the approaches.
- Gathering published turnover rates of European tree species in dependency on e.g. forest ecosystems, soil types, and climatic factors.
- Resolving controversies and giving common agreements on turnover methods and calculations for root researchers.
- Resolving controversies and giving common agreements on turnover rates to be used by modellers.
- Putting together the outcomes and writing peer-reviewed publication for international journals.

WG2: The tasks of WG2 are mainly the gathering of knowledge, discussion, and giving common agreements on the response of the following key processes undertaken by mycorrhizal mycelia: 1) Turnover of hyphae; 2) Decomposition of hyphae; 3) C flux through mycelium; 4) Interactions with soil biodiversity; v) Incorporation into predictive models:

- Collecting and itemizing the literature on methods and calculation formulas to estimate mycorrhizal mycelia biomass, production, mortality, lifespan, decomposition, and turnover rates, e.g. mesh bags, FACE experiments, substrates of C4 plants, ¹³C and ¹⁴C isotopes, PFLA analysis, other methods.
- Comparing and evaluating the current methods for the mycorrhizal mycelia biomass and turnover estimations and calculations, summarizing the advantages / disadvantages and strengths / weaknesses of the approaches.
- Gathering published turnover rates of European fungal species and their dependency on e.g. forest ecosystems, soil types, or climatic factors.
- Determining the importance of mycorrhizal fungal diversity, e.g. whether species forming heavily melanised mycelia (e.g. *Cenococcum* species) decompose at different rates compared to non-melanised mycelia (e.g. *Amanita* species); the consistency of species response to elevated CO₂ and climate change.
- Evaluating the methods to quantify rates of C allocation to mycorrhizal mycelia and onwards to other soil microorganisms.
- Evaluate the relationship between the responses of mycorrhizal mycelia compared to fine roots.
- Resolving controversies and giving common agreements on turnover methods and calculations for mycorrhiza researchers.
- Giving common agreements on turnover rates to be used by mathematical ecologists.
- Putting together the outcomes and writing peer-reviewed publications for international journals.

WG3: The tasks of WG3 are mainly the gathering of knowledge, discussion, and giving common agreements on soil C pools and turnover rates:

- Collecting and itemizing the literature on SOM pools and dynamics in different forest ecosystems, taking into account the variability of climatic conditions, of vegetation and of soil types.
- Comparing the methods to evaluate 1) SOM pools from the qualitative to the quantitative descriptive approaches (i.e. humus forms, chemical fractionation, physical fractionations according to different methods); 2) SOM dynamics (stabilization, decomposition, mineralization), taking into account both the pre-treatment step (e.g. fractionation, chemical hydrolysis and oxidation for labile C or lignin evaluation) and the instrumental methods used for the characterization, e.g. ^{13}C and ^{14}C isotopes, ^{13}C liquid and solid Nuclear Magnetic Resonance (NMR) and Fourier-Transformations-Infrared (FTIR) analyses, Gas Chromatography-Mass Spectrometry (GC-MS); 3) C release from the soil (e.g. released form, conditions for field or laboratory experiments).
- Discussing and evaluating the importance of stabilization processes, e.g. chemical, physical, biochemical stabilization.
- Assessing the effects of increasing atmospheric CO_2 concentration (through changing biomass input) and changing temperature and moisture on soil processes affecting soil C stabilization and storage.
- Comparing and evaluating the current methods for the soil C turnover estimations and calculations, summarizing the advantages / disadvantages and strengths / weaknesses of the approaches.
- Resolving controversies and giving common agreements on methods and calculations for biogeochemist researchers.
- Resolving controversies and giving common agreements on turnover rates to be used by modellers.
- Putting together the outcomes and writing peer-reviewed publications for international journals.

WG4: The tasks of WG4 are mainly the gathering of knowledge, discussion, and giving common agreements on biogeochemical models which apply turnover rates:

- Collecting and itemizing the literature on biogeochemical models, such as Biome-BGC, LPJ-GUESS, GOTILWA+, Yasso, and on models which apply e.g. fine root turnover rates.
- Discussing and evaluating models where the incorporation of new modules such as mycorrhizal mycelia turnover rates or soil C stocks and soil C turnover rates can be integrated or incorporated.
- Comparing and evaluating the current biogeochemical models for belowground C or forest ecosystem modelling, summarizing the advantages / disadvantages and strengths / weaknesses of the approaches.
- Integrating the outcomes of the WG1, WG2 and WG3 into suitable models which include belowground C turnover rates and running them.
- Resolving controversies and giving common agreements on biogeochemical modelling approaches and models for belowground C and forest ecosystem modellers in dependency on e.g. forest ecosystems, climatic factors, a.o.
- Sensitivity analyses of BGMs, including alternative process representations.
- Upscaling of belowground C dynamics achieved at the site scale to regional to global scales.
- Communicating the remaining uncertainties to researchers, issue managers, policy makers, and stakeholders.
- Proposing and developing sustainable belowground C management strategies to ensure a maximum of resilience under adverse or gradually changing environmental conditions.
- Putting together the outcomes and writing peer-reviewed publications for international journals.

E. ORGANISATION

E.1 Coordination and organisation

The COST Action will be coordinated by a Management Committee (MC) defined according to "Rules and Procedures for Implementing COST Actions" (doc. COST 299/06). The responsibility for the planning and execution of the activities will be delegated by the MC to a Steering Group (SG) consisting of the Chair and Vice-Chair of the Action, and the coordinators of Working Groups (WG).

The core of activities will be carried out at the WG levels, where knowledge sharing, resulting from research carried out in and financed by the participating countries, and the preparation for knowledge transfer will be undertaken. For this purpose, the coordination of research will be implemented through annual WG meetings, where state of the art reports and other activities will be decided and organized. The participation of young scientists in the activities of these WG will be encouraged through STSMs. The Vice-Chair of the Action will act as a STSM manager.

Biogeochemical modelling will be a fundamental part of all WGs.

Milestones of the Action include:

- Kick-off meeting, where the MC, WG coordinators and SG will be defined, as well as work plan implementation and task distribution.
- WG annual meetings, where an evaluation of the activities carried out by participating members and the discussion and presentation of state-of-the-art reviews and knowledge transfer plans will be made.
- Training schools, each of the two training schools will represent a milestone in the Action.
- Final conference, where a comprehensive state-of-the-art and dissemination of the results of the Action will be made.
- Review articles, where major Action achievements will be summarized and published.

An Action website will be set up to be used as means to network between Action participants and ensuring the dissemination or exploitation of the results of the Action. This site will be used to announce activities (e.g. training schools, WG meetings, conferences), facilitate communication between the participants (e.g. discussion papers, databases) and disseminate results (e.g. state-of-the-art reports, review articles).

E.2 Working Groups

The Action will have four Working Groups (WG), each WG being responsible for the different tasks:

- WG1 - Fine root turnover.
- WG2 - Mycorrhizal mycelia biomass and turnover.
- WG3 - Soil C stocks and turnover.
- WG4 - Biogeochemical modelling.

All participants will take part in WGs according to their field of expertise or interest. Each WG will be coordinated by a WG coordinator. Besides the co-ordination of the respective WG, each WG coordinator will be responsible for reporting the work progress to the SG.

E.3 Liaison and interaction with other research programmes

The liaison with other COST Actions and other European and international research programs will be managed by the SG. In particular, the COST Actions FP0603 Forest Models for Research and Decision Support in sustainable Forest Management and FP0703 Expected Climate cHange and Options for European Silviculture (ECHOES) may profit from the results of this Action, as forest and ecosystem modelling is a part of all these Actions. Experts participating in these Actions will be invited to MC or WG meetings, both to use their expertise and recommendations. The new

developments of belowground C dynamics modules for BGMs will be made available as community developments, which then can be implemented into the next generation of global biosphere models, currently under development in a variety of projects, such as QUEST.

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 MC will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. The involvement of early-stage researchers will be promoted in STSM, active participation in state-of-the-art reviews, and training schools. In the WG meetings, early-stage researchers are encouraged to participate with oral presentations and posters. In terms of gender balance, priority will be given to the active participation of women in the work program of the Action, when deciding on WG composition and task coordination.

F. TIMETABLE

The Action will have a duration of four years. A tentative timetable is provided below:

	Year 1				Year 2				Year 3				Year 4			
MC/SG meetings	x				x				x				x			
WG1 meetings			x			x				x				x		
WG2 meetings			x			x				x				x		
WG3 meetings			x			x				x				x		
WG4 meetings			x			x				x				x		
STSMs			x	x			x	x		x	x			x	x	
Training-schools										x					x	
Review-papers											x	x	x	x	x	x
Final conference																x
Web-page		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

- Management Committee (MC) and Steering Group (SG) meetings will coordinate all the activities of the Action. The first MC meeting will be used for the planning and organization of the Action, including Steering Group (SG) composition, Working Group (WG) structure and composition, decision on state-of-the-art reviews. The MC/SG will be organized usually once, but up to 3 meetings per year might be considered.
- WG meetings will be held every year, to evaluate progress, schedule activities for the following year, and assure a smooth progress of the work plan. The first set of WG meetings will occur at the end of year 1, to allow more time to decide WG structure, WG participant composition, and task and subtask coordinators,
- Two training schools will be organized in Years 2 and 3. Short-Term Scientific Missions (STSM) will be carried out every year.
- Peer-reviewed and state-of-the-art review-papers on the scientific tasks will be coordinated and written in Years 2 to 4. This will be submitted in the beginning of Year 4.
- A final conference will be organized in Year 4, including the Action conclusions and dissemination of results.
- The web-page will be maintained during the duration of the Action.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CH, CZ, DE, EE, ES, FI, FR, UK, GR, HR, IL, IS, IT, LT, LV, NL, NO, PL, PT, RS, SE, SI, SK, TR.

On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 104 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?

Three main target audiences are foreseen for the dissemination of the Action results:

- Researchers and modellers who investigate soils of forest ecosystems and who apply soil and biogeochemical models.
- Forest managers who are responsible for a sustainable management of the belowground C pools in European forest.
- Regional and national representatives of governments, who have to report on the C budgets of their countries due to the Kyoto protocol.

H.2 What?

Dissemination includes:

- A public website for general dissemination of the Action activities and results and an e-mail network for people interested in the topic will be created. This will allow dissemination to the audiences hardly reached by scientific publications during the full duration of the project. In addition, the Action will have various dissemination methods that will be specific according to target audiences:
 - Target audience 1: Researchers and modellers: Compiling of articles and review-articles on the different elements of the belowground C cycle in scientific journals during participation in WG meetings and conferences, participation in STSMs and training schools for young researchers.
 - Target audience 2: Forest practitioners and managers: State-of-the-art reports, final reports and case study reports in technical journals to be developed within WG activities, Schools and Universities in Forestry will be contacted to ensure dissemination of the results also to the next generation of forest managers, organization of technical sessions during the final conference.

- Target audience 3: Government representatives and decision/policy makers: Compilation of non-technical publications within WG activities, introductory of non-technical sessions during the final conference.
- Participation of the members in the WG meetings with the delivery of abstract books of the oral and poster contributions.
- Peer-reviewed review-articles in international journals, to be compiled and developed within the WG activities by the end of the Action.
- The organization of two Training Schools (e.g. on turnover and modelling) aiming to provide to young researchers and modellers the state-of-the-art in terms recording and measuring turnover and to apply the BGMs.
- The organization of a major conference on belowground C turnover and BGMs at the end of the Action duration, to disseminate Action conclusions and results, and advertising the review-articles.

H.3 How?

The SG will elaborate a more detailed dissemination plan. The approximate dates for the main publications and events are mentioned in section H2.