Climate change can soil make a difference?

soil

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Report on the conference

Climate change – can soil make a difference?

Brussels, Thursday 12 June 2008

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Preface

The Environment Directorate-General of the European Commission organised a high-level conference on 12th June 2008 in Brussels to discuss the relationship between soil as a repository of organic carbon and climate change. This Report contains a summary of the presentations and the discussions held at the conference.

Soil is an environmental medium that is often neglected because people sometimes do not realise the importance it has for the ecosystem and the economy. The food we eat, the clothes we wear, the water we drink – they are all related to the capacity of soil to perform its fundamental functions. When soils are degraded, this capacity is seriously impaired. Moreover, when the degradation reaches serious levels, it can result in desertification phenomena. These are affecting not only drylands, but also European countries, and are expected to increase due to climate change. In addition to its functions linked to biomass and fibre production, nutrient recycling and water filtration, gene pool and archive of our geological and archaeological heritage, soil plays a crucial role in the global carbon cycle. The exploration of that role was the objective of the conference.

Soil organic matter is the second biggest carbon pool of the planet after the oceans. In the European Union (EU) alone there are more than 70 billion tonnes of organic carbon in the soil. Releasing to the atmosphere just a small fraction of that amount runs the risk of wiping out all the savings that other sectors of the European economy are achieving in order to contain anthropogenic greenhouse gas emissions. Unfortunately, this is not a theoretical scenario, as the reader will be able to see from some of the presentations made at the conference.

There are several varied factors contributing to losses of carbon from soils. Long-term changes in land management practices driven essentially by changing economic circumstances may be among them. In Europe (and elsewhere in the industrialised world), we have, over the past century or so, completely mechanised and streamlined many of our farming systems, specialising production and simplifying management. In making these changes, most of which have brought strong socio-economic benefits, we have taken our eyes off what is happening to soils. Land management approaches, largely not related to soil management, have played centre role in expanding productivity. It now appears that slow and gradual reductions in soil organic matter is taking place, not fully assessed at field level but very significant when taken as a whole in terms of carbon emissions. The atmosphere, of course, makes no distinction regarding the origin of carbon dioxide insofar as climate change is concerned.

But long-term changes in land management are not the full picture. Changes in rainfall patterns and increases in average temperatures brought about by climate change are also playing a role. A rise in global temperature accelerates carbon losses from soils, driving up the concentration of carbon dioxide in the atmosphere. The changes in rainfall patterns will, of course, additionally contribute to an increase in erosion in vulnerable soils, which often already suffer from low organic matter content. Climate change will thus put further pressure on soil quality and will increase the risk of desertification and land degradation, which is already affecting the southern Member States of the European Union and is expected to move gradually northward.

Are we therefore doomed to see soil degradation rising and ever increasing losses of organic matter from soil because of climate change?

The distinguished scientific speakers who participated in the conference were clear in their overall message. It is more urgent than ever to act in favour of appropriate policies and practices that favour maintaining or even increasing soil organic matter levels. We should

start with protecting peatlands because of the huge amount of carbon they store – not to mention their role in terms of water filtration and their rich biodiversity. We should then turn our attention to inadequate agricultural practices and to their drivers, bearing in mind that the more organic carbon we keep in or add to the soil, the less carbon dioxide we will have in the atmosphere. Indeed, one of the speakers at the conference estimated that the total carbon sink capacity of terrestrial ecosystems is equivalent to offsetting about 50 parts per million of atmospheric carbon dioxide out of a current total of approximately 380 parts per million.

While the capacity of soil to act as a carbon sink can be limited in quantity and time, it offers the great advantage of being available right now (no need to develop and test new technologies), well understood (it just exploits a natural process), and not expensive, as most of the time it simply requires a change of practices that is self-financing in the medium term. The real challenge is to ensure that soil organic matter management and its potential for preventing desertification and contributing to climate change mitigation and adaptation is brought to the attention of land users and policymakers, so that they can factor that into their daily activities and into policy development, respectively.

The statements made at the conference by the President of the Environment Council, the Environment Minister of Iceland, the Secretary of State of Portugal, the Vice-President of the Temporary Committee on Climate Change of the European Parliament, and the Rapporteur on the EU's Soil Thematic Strategy in the European Economic and Social Committee clearly demonstrated the importance they attached to robust policies in support of soil protection in general and for maintaining soil organic matter levels in particular. Many see the proposal by the European Commission for a Soil Framework Directive as a powerful tool for ensuring that soil can contribute to climate change mitigation and adaptation. They urged its speedy adoption by the EU's legislature.

The European Commission and the United Nations Convention to Combat Desertification (UNCCD) are convinced that if we do not protect soil organic matter in Europe and elsewhere in the world, we will not have productive soils for long, we will not be able to cope with prolonged water shortages, we will not be able to cope with more frequent periods of intense rain, and we will not reverse worrying land degradation and desertification trends. We are convinced that the presentations and the discussions held at the conference and summarised in this Report will provide useful information to decision and policy makers concerned with soil management at all levels.

Stavros DIMAS
Commissioner for Environment
European Commission
Brussels

Luc GNACADJA
Executive Secretary
UN Convention to Combat Desertification
Bonn

Executive Summary

The conference on *Climate change – can soil make a difference?* took place in Brussels on 12 June 2008. It was organised by the Environment Directorate-General of the European Commission with the aim of highlighting the link between soil and climate change, and therefore the transboundary dimension of soil degradation phenomena such as erosion, loss of soil organic matter and desertification.

Approximately 300 people attended the conference, making up a varied audience composed of policy-makers, civil servants from national and regional administrations, researchers, lobbyists, and officials from the European Commission. Most notably, the President of the Environment Council, the Environment Minister of Iceland, the Portuguese Secretary of State for Environment, the Vice-President of the Temporary Committee on Climate Change of the European Parliament and the Rapporteur on the Soil Thematic Strategy in the European Economic and Social Committee were also in attendance.

Mr Luc Gnacadja (Executive Secretary of the United Nations Convention to Combat Desertification) was in the Chair. He reminded the audience that very low soil organic matter levels are one of the key factors that contribute to desertification, and that the consequences of desertification are devastating for the lives of so many of the world's poorest people.

The conference was opened by Mr Stavros Dimas (Commissioner for the Environment, European Commission), who underlined that soil organic matter is a major contributor to soil fertility, the elixir of life in fact, particularly plant life – a concept that was echoed and taken up by many other speakers during the day. Equally important was the fact that it is the second biggest carbon pool on the planet after the oceans. In the European Union (EU) alone there are more than 70 billion tonnes of organic carbon in our soils. This is a huge amount bearing in mind that the EU emits approximately 2 billion tonnes of carbon a year. He went on to say that there was a need to protect and enhance this carbon pool. Thus, the Council needed to move forward on the proposal for a Soil Framework Directive, as the EU could not afford to waste time and allow more and more soil organic matter to be lost from the soil. According to Mr Dimas, this was a problem with at least a European if not a worldwide dimension, which needed a European solution.

Despite coming from different countries and backgrounds, with varied scientific interests and convictions, the overall message that the conference heard from the invited leading scientists was quite unanimous: soil is part of the climate change problem, but can – and must – also be part of the solution. To what extent soil emitted greenhouse gases and to what extent the processes leading to these emissions could be reduced would need further work before it can be better understood and quantified. But the general picture was clear – by adopting sound soil management practices, maintaining and – if at all possible – increasing carbon in soil can help to offset fossil fuel emissions (according to Professor Lal, the potential carbon sink capacity of terrestrial ecosystems is equivalent to offsetting about 50 parts per million of atmospheric carbon dioxide, which is currently in the region of 380 parts per million).

While reminding the audience that the soil carbon pool was limited in terms of capacity and was not necessarily permanent, Professor Smith presented a strong argument in favour of soil sequestration, and soil sequestration now. This was because emissions or reduced emissions over the next 10 to 20 years will determine the kind of temperature increase – from +2 to +6°C or more – that the world will experience by 2100. He stressed that all sectors of human activities – LULUCF (land use, land use change, forestry) and agriculture included – have to make a contribution, hence the importance of sound soil management practices to keep or increase soil organic matter.

Dr Liski and Dr Freibauer underlined the importance of natural peatlands as both a repository of carbon but also as a potential source of methane and nitrous oxide – not to mention their role in terms of water filtration and their rich biodiversity. In their views, protecting peatlands and helping to restore them where they are already drained is the most urgent action that needs to be undertaken to reduce the huge greenhouse gas emissions from peat soils. Along the same lines, Dr Arrouays pointed out that preserving existing carbon stocks might be more important than trying to create new ones.

It was remarked during the discussions that there was an urgent need to quantify where and how much European soils are losing organic matter. Albeit with significant uncertainty, it was known that soils are losing carbon and – to a certain extent – it was possible to estimate the amount of this loss. However, the EU was far from being in the situation of the United Kingdom presented by Mrs Bellamy, where a soil monitoring system had been in place for decades. Identifying and quantifying soil organic matter losses were fundamental preconditions for effective implementation of soil protection measures.

The panel discussion, moderated by Mr Grant Lawrence (former Director in the Environment Directorate-General of the European Commission), was introduced by a statement recorded on 4 June 2008 by Mrs Nathalie Kosciusko-Morizet (French Secretary of State for Ecology). She was of the opinion that soil should be included as a mandatory accounting category for industrialised countries in any post-Kyoto agreement and that the CAP should address climate change aspects further and enable farmers to take climate change considerations fully into account. She added that the proposal for a Soil Framework Directive would be on the agenda of the French Presidency, since the Directive would contribute to carbon storage in soils.

Mr Janez Podobnik (Minister of the Environment and Spatial Planning of Slovenia and President of the Environment Council) wondered whether Community measures to reduce the impact of climate change should not include permanent monitoring of reference areas and measures for sound soil management in an effort to preserve and increase the capacity of soil to capture carbon dioxide. He also reiterated Slovenia's support for the Soil Framework Directive and agreed with Mrs Kosciusko-Morizet on the need to restart the stalled negotiations.

Mrs Þórunn Sveinbjarnardóttir (Minister for the Environment of Iceland) stressed the link between the Convention to Combat Desertification, the Framework Convention on Climate Change, the Convention on Biodiversity, and food security, especially in less developed countries. A common thread of all these conventions is the importance of soils and ecosystem services. Carbon in soils is the fundamental ingredient of soil fertility and is a vital part in the role of soils in ecosystem services, such as water retention.

Mr Humberto Rosa (Secretary of State for Environment of Portugal) made a passionate plea in favour of soil protection, the importance of soil organic matter and the need to adopt the Soil Framework Directive as soon as possible, since European legislation was necessary in this field.

Mr Vittorio Prodi (Vice-President of the Temporary Committee on Climate Change of the European Parliament) echoed Mr Rosa's views and assured the audience of his personal support in making every possible effort to arrive at a positive outcome on this legislative proposal.

Mr Staffan Nilsson (European Economic and Social Committee) recalled the opinion adopted by his Institution in favour of European legislation on soil protection, despite the intense lobbying by farmer organisations. He mentioned the importance of organic improvers and sewage sludge for maintaining sufficient soil organic matter levels. He called on the Commission to revise the Sewage Sludge Directive, because sewage sludge should be used only if the levels of contaminants (heavy metals and organic compounds) were to be lowered.

In his concluding remarks, Mr Jos Delbeke, Deputy Director-General of the Environment Directorate-General of the European Commission, summarised the key points to emerge from the presentations and the discussions:

- Soil was both part of the problem and of the solution for climate change. It was imperative to support land use practices that help to maintain and – if at all possible –increase soil organic matter.
- Soil degradation had transboundary effects, and thus there was a need for a common European legislative framework to tackle this phenomenon and, in particular, to find out where soil organic matter losses were happening, and to quantify those losses.
- It was clear that the European Union (and the world) had to adapt to climate change and that soil had a crucial role to play to secure food and services against negative climatic conditions.

The conference was concluded by Mr Luc Gnacadja, who underlined the importance of continuing the debate on the relationship between climate change, loss of soil organic matter and desertification, in a bid to reverse unsustainable trends.

The full presentations are available at http://ec.europa.eu/environment/soil/conf_en.htm

Conference programme

8.00 **Registration desk opens**

9.00 Welcome
Mr Michael Hamell, Head of Unit, Environment DG, European Commission

9.05 Introduction by the Chair
Mr Luc Gnacadja, Executive Secretary, United Nations Convention to Combat Desertification, Bonn, Germany

Key note address

9.15 Why is soil organic matter so important?
Mr Stavros Dimas, Environment Commissioner, European Commission

First session
Soil – the biggest terrestrial carbon pool

9.30 The projected effects of climate change in Europe
Professor Jean-Pascal van Ypersele, Vice-Chair of WG II 'Climate Change Impacts, Adaptation and Vulnerability' of IPCC, Professor at the Institut d'Astronomie et de Géophysique 'Georges Lemaître,' Université catholique de Louvain, Louvain-la-Neuve, Belgium

10.00 The role of soil organic matter in the global carbon cycle
Professor Rattan Lal, Ohio University, Carbon Management and Sequestration Center, Columbus, Ohio, United State of America

10.30 Questions and answers

11.00 Coffee break

Second session
The evolution of soil carbon stocks

11.30 UK losses of soil carbon – due to climate change?
Mrs Pat H. Bellamy, National Soil Resources Institute, Cranfield University, United Kingdom

11.45 Emissions from peat soils
Dr Jari Liski, Finnish Environment Institute (SYKE), Research Programme for Global Change, Helsinki, Finland

12.00 Changes in soil organic matter in relation to land use and agricultural practices
Dr Dominique Arrouays, Directeur Unité Infosol, INRA, Orléans, France

12.15 Emissions due to land use changes in Brazil
Professor Carlos C. Cerri, CENA-USP, Laboratório de Biogeoquímica Ambiental, Piracicaba, Brazil

12.30 Questions and answers

13.00 Break for lunch

Third session

How to ensure that soil is part of the solution to climate change?

14.30 The role of agricultural practices in keeping or increasing soil organic matter
Professor Peter Smith, Lead Author of the IPCC Good Practice Guidelines 2006, Professor of Soils and Global Change, University of Aberdeen, United Kingdom

15.00 Evaluation of the potential of selected measures to reduce carbon emissions and sequester carbon in European soils
Dr Annette Freibauer, Co-ordinator of the EU CarboEurope-Integrated Project, Max-Planck-Institute for Biogeochemistry, Jena, Germany

15.30 Questions and answers

16.00 Coffee break

Fourth session

16.30 **Panel discussion on the policy implications**
Moderator:
Mr Grant Lawrence, former Director in the Environment Directorate-General of the European Commission, Brussels

Participants:

- Mr Janez Podobnik, Minister of the Environment and Spatial Planning, Slovenia
- Ms Þórunn Sveinbjarnardóttir, Minister for the Environment, Iceland
- Mr Humberto Rosa, Secretary of State for Environment, Portugal
- Mr Vittorio Prodi, Rapporteur on the Soil Thematic Strategy and Vice-Chairman of the Temporary Committee on Climate Change, European Parliament, Brussels
- Mr Staffan Nilsson, Rapporteur on the Soil Thematic Strategy, European Economic and Social Committee, Brussels

Final remarks

18.00 *Mr Jos Delbeke, Deputy Director-General, Environment DG, European Commission*

18.10 Closing remarks by the Chair
Mr Luc Gnacadja, Executive Secretary, United Nations Convention to Combat Desertification, Bonn, Germany

18.15 **End of conference**

18.15- **Cocktail reception**

19.45

Introduction by the Chair

Mr Luc Gnacadja,
Executive Secretary of the United Nations Convention to Combat Desertification

Excellences Mesdames et Messieurs les Ministres,

Monsieur le Commissaire à l'Environnement de la Commission européenne,

Mesdames et messieurs les experts et chercheurs,

Distingués participants,

Je voudrais avant tout propos, féliciter la Direction Générale de l'Environnement de la Commission européenne pour cette remarquable initiative, et vous remerciez cher M. Dimas, Commissaire européen à l'environnement pour m'avoir invité à présider cette conférence. Je crois qu'elle sera une contribution majeure dans la dynamique nécessaire pour opérer un véritable changement de paradigme dans l'approche actuelle du combat pour faire face aux changements climatiques qui menacent notre existence même.

Ce changement de paradigme est une nécessité, une exigence et une urgence.

Pensez donc ! Au cours des quinze dernières décennies, l'humanité a créé une machine infernale en dégradant à la fois le sol et l'atmosphère qui à leur tour se dégradent réciproquement. Et pour briser ce cercle vicieux nous n'avons à ce jour orienté nos attentions que vers l'atmosphère. C'est une démarche insuffisante voire même une voie sans issue !

Il y a urgence à atteindre des objectifs plus ambitieux de réduction de nos émissions de gaz à effet de serre.

Il y a donc nécessité à y associer tout le monde y compris ceux qui ne sont pas la cause du problème qui menace néanmoins de les emporter en premier, je veux parler des populations des pays en développement.

C'est par conséquent une exigence que d'utiliser tout le potentiel humain ainsi que celui de la nature pour relever les défis des changements climatiques.

So, can soil make a difference?

In order to cope with the challenge, we need to solve a multitude of problems simultaneously. The burden of poverty must be reduced, particularly in the rural areas. Ways and means for effective adaptation to and mitigation of climate change, as well as for cutting further release of carbon dioxide into the atmosphere must be identified and implemented. Provision of adequate and affordable food must be ensured.

In this context, the global importance of enhanced land and soil management is becoming increasingly clear.

As we shall soon hear from a number of experts, carbon as plant organic matter is sequestered in soils. Consequently soils contain more carbon than is contained in vegetation and the atmosphere combined. This has important implications to considerations on climate change.

We will also hear about various methods that significantly enhance carbon sequestration in soil while improving soil properties. Although these methods are widely recognized by the scientific community, they are yet to be applied at a large scale, and thus provide major opportunities in increasing carbon sequestration.

Indeed, interlinkages between soil and climate change are significant and should be better reflected in policy-making processes.

Increased attention to land and soil in the negotiation tables on climate change would not only enrich the substantive and conceptual debates on effective means for carbon sequestration. It would also provide a new and a highly interesting platform for developing countries to engage into the adaptation and mitigation agendas, considering that for many of them soil is the single most important capital and asset for development.

Bringing agricultural land use into the realm of implementation mechanisms on climate change could re-define the concept and the content of international development cooperation. The current country-driven system would be complemented by collaboration arrangements between private sector stakeholders, with rural areas in developing countries among the beneficiaries. The political implications, as well as the increase of volume in financial and technological transactions targeting agriculture, as well as the improvement of the livelihood of the most vulnerable could be enormous.

However, there are yet many questions to be solved in better linking soil and climate change, particularly those concerning monitoring methodologies.

Distinguished participants,

The United Nations Convention to Combat Desertification (UNCCD), is the sole multilateral environmental agreement (MEA) on land and soil degradation. It is one of the so-called Rio Conventions, thus a "sister convention" to the conventions on climate change and biodiversity.

A positive resolve to stimulate UNCCD implementation was expressed last September in Madrid, as Parties to the Convention adopted the 10-year strategic plan and framework to enhance the implementation of the Convention (2008-2018). The new strategy targets the use of effective and practical approaches to sustainable land management with synergy as a systemic approach.

The main strategic objectives are:

- To improve the livelihood of affected populations;
- To improve the productivity of affected populations;
- And thirdly, my favourite, to generate global benefits;
- To mobilize resource to support the implementation of the Convention through building effective partnerships between national and international actors.

The decision adopting the Strategy also called for managerial and systemic reforms toward RBM (result based management) in the UNCCD processes. Those reforms imply inter alia:

- Under the CST (Committee on Science and Technology), a commonly agreed and globally recognized baselines and indicators to monitor desertification, land degradation and drought;
- Under the CRIC (Committee for the Review of the Implementation of the Convention), new and standardized reporting guidelines for all parties and stakeholders of the Convention.

So, I trust this conference's outcomes will be valuable inputs for those reforms in progress and for improving the synergies in the implementation of the Rio Conventions.

To all of us, I wish a very fruitful conference.

Thank you.

Key Note Address

Mr Stavros Dimas,
Commissioner for Environment, European Commission

Mr Chairman,

Ladies and gentlemen,

It is my pleasure to welcome you to Brussels today to discuss the relationship between soil and climate change. The very large attendance of more than 400 people from almost all Member States and beyond, including at high political level is a clear reflection of the enormous interest in the subject. It shows an increased awareness of the need to address soil conservation and management in the light of climate change.

At the outset, I want to thank Mr Gnacadja, Executive Secretary of the United Nations Convention to Combat Desertification, for acting as today's Chairman. Mr Gnacadja will surely remind us that very low soil organic matter levels are among the key factors that contribute to desertification, and of the consequences of desertification for the lives of so many of the world's poorest people.

But why should we in Europe be so concerned by the relationship between soil and climate change?

The key is "*soil organic matter*". As you in this audience well know, soil organic matter is an extremely precious resource that performs essential functions for the environment and for the economy, and it can do so because it is a whole ecosystem at a microscopic scale.

Organic matter is a major contributor to soil fertility. It is the elixir of life, particularly plant life, as it binds nutrients to the soil, thus ensuring their availability to plants. It is the home for soil organisms, from bacteria to worms and insects, and allows them to transform plant residues, and hold on to nutrients that can be taken up by plants and crops. It also maintains soil structure, thereby improving water infiltration, decreasing evaporation, increasing water holding capacity and avoiding soil compaction. In addition, soil organic matter accelerates the break down of pollutants and can bind them to its particles, so reducing the risk of run-off.

But this is not all. Equally important is that soil organic matter is the second biggest carbon pool in the planet after the oceans. In the EU alone there are more than 70 billion tonnes of organic carbon in our soils. This is a huge amount if we bear in mind that the Member States of the European Union altogether emit about 2 billion tonnes of carbon annually. Indeed, releasing to the atmosphere just a small fraction of that carbon currently stocked in our soils runs the risk of wiping out all the savings that other sectors of the economy are achieving in order to contain anthropogenic greenhouse gas emissions. This is not a theoretical scenario, unfortunately, and some of the scientists who will speak here today will present data suggesting that large amounts of carbon from soil organic matter have indeed already been lost to the atmosphere in the recent past.

You may wonder, what is causing this loss of soil organic matter? This conference today will certainly provide some answers to this question but there appear to be several varied factors contributing to losses of carbon from soils.

Long term changes in land management practices driven essentially by changing economic circumstances may be among them. We have, for instance, over the past century or so, completely mechanised and streamlined many of our farming systems, specialising production and simplifying management. In making these changes, most of which have brought strong socio-economic benefits, we have taken our eyes off what is happening

to soil. Land management approaches, largely not related to soil management, have played centre role in expanding productivity. It now appears, that slow and gradual reductions in soil organic matter may have taken place, almost insignificant in themselves at field level but very significant when taken as a whole in terms of carbon emissions. The atmosphere, of course, makes no distinction regarding the origin of carbon dioxide insofar as climate change is concerned.

This has to lead us firstly to examine thoroughly if and where soil organic matter is declining throughout our territories, then to establish approaches to redress the situation and to implement these approaches so that soil not only retains its organic matter but, – where possible – becomes a sink for more carbon and therefore contributes to the fight against global warming.

But long term changes in land management are not the full picture. Changes in rainfall patterns and increases in average temperatures brought about by climate change are also playing a role. A rise in global temperature accelerates carbon losses from the soil, driving up the concentration of carbon dioxide in the atmosphere. The changes in rainfall patterns will, of course, additionally contribute to an increase in erosion in vulnerable soils which often, themselves, suffer from low organic matter content. Climate change will thus put further pressure on soil quality and will increase the risk of desertification, which is already affecting the southern Member States and is expected to move gradually northward.

It is therefore more urgent than ever to act in favour of appropriate policies and practices that favour maintaining or even increasing soil organic matter levels. If we manage to do that – and we have to do it now! – we have at our disposal a formidable tool for sequestering carbon and supporting the achievement of the targets we have set ourselves to combat climate change. The more organic carbon we keep in or add to the soil, the less carbon dioxide we will have in the atmosphere.

This will not only mitigate global warming, it will also diminish desertification risks, thereby sustaining agricultural production and allowing us to keep feeding the ever growing world population. In this context, the current world food crisis is of particular relevance. The Commission recently presented a Communication on this subject acknowledging the many causes of the current problem. These include increased demand for commodities and decreased supply due largely to weather related production shortfalls in several regions of the world. Forecasts for future long term trends in climate all indicate greater droughts in some areas and more rainfall – even too much – in others. It is clear that we can expect weather related supply difficulties to reoccur in coming decades. Long term soil management has a role to play in countering such difficulties. Soil organic matter can absorb up to twenty times its weight in water and so can play a positive part in mitigating the impacts of more extreme rainfall intensity and more frequent and severe droughts.

Therefore, preserving and increasing soil organic matter levels to the extent possible can be a significant tool in mitigating climate change, securing our food supply, and combating desertification. And our efforts will not only improve the situation in Europe, as – I am sure – they will contribute to solving these problems at the global level as well.

Ladies and gentlemen,

Human actions taken without awareness of their long term global consequences are clearly at the root of climate change. The good news is that it is in our power to modify this situation and to address climate change! For soil organic matter, as our knowledge grows, we can develop the opportunities to take corrective action for the benefit of sustainable agriculture, for nature protection and to mitigate climate change.

For example, recent reforms of the Common Agricultural Policy have begun to take steps in this direction.

Moreover, it is partly for this reason that the Commission has proposed ground breaking legislation for soil. This aims – for the first time in the European Union – at protecting soil and the crucial functions it plays – including acting as a carbon pool. The European Parliament has understood fully the importance of the proposal and adopted it, strongly emphasising the need for protecting soils against the negative effects of climate change. Now the Council needs to move forward on this file, because we cannot afford to waste time and allow that more and more soil organic matter goes up – literally – in smoke. This is a problem with at least a European if not a worldwide dimension, which needs a European solution.

Furthermore, in autumn will present a White Paper on adaptation to climate change. It will show the importance of increasing the resilience of soil to climate change and how a healthy soil, sufficiently rich in organic matter, will allow our entire society and economy to better adapt to the impacts of climate change. I will ensure that the outcome of this conference will feed into the Commission's thinking on the relationship between soil policies and climate change mitigation and adaptation. I express the hope that you will do the same at the national or regional level.

I began by thanking Mr Gnacadja for acting as chairman; my thanks also go to the high-level European and non-European speakers who have travelled from as far as Brazil or the United States to come and present the results of their research. I am a believer in the need for policies to be based on sound scientific advice, and today's conference represents a golden opportunity for the scientific community to make its voice heard.

Last but not least, I would like to express my sincere thanks to the Members of the European Parliament, of the European Economic and Social Committee, to the President of the Environment Council, to the Portuguese Secretary of State and to the Environment Minister of Iceland for accepting my invitation to participate in the panel discussion that will close the conference. I am sure they will take stock of today's deliberations and will present their valuable views on the policy perspectives in front of us.

Ladies and gentlemen,

I firmly hope that this conference will bring to the attention of a wider audience the scientific elements that underpin the EU's action in the fields of soil protection and climate change adaptation and mitigation. I am confident that it will also prove to be an important milestone in the difficult road leading to a better understanding of the role that soil plays in the global ecosystem and the need for greater efforts to ensure and protect that role.

I wish you a very informative and constructive day, and thank you for your attention.

Summary of presentations[1]

The projected effects of climate change in Europe

Professor Jean-Pascal van Ypersele, Vice-Chair of WG II 'Climate Change Impacts, Adaptation and Vulnerability' of IPCC, Professor at the Institut d'Astronomie et de Géophysique 'Georges Lemaître', Université catholique de Louvain, Louvain-la-Neuve, Belgium

Professor van Ypersele started his presentation with an explanation of the structure and role of the Intergovernmental Panel on Climate Change (IPCC), which derives its strength from the rigorous scientific basis used for its operations. World-class scientists are appointed as authors of the IPCC reports on the basis of their publication record.

According to the IPCC's Fourth Assessment Report (AR4)[2], there is unequivocal evidence that the climate system is warming up with a very high confidence that this is due to human activities since the Industrial Revolution. As a consequence, the last 50 years are likely to have been the hottest in the past 1 300 years. Without mitigation measures, global temperature could increase by 1.1 to 6.4°C (or even higher) by 2100 compared to 1990 and sea levels could rise by 0.18 to 0.59 m. The regions most affected will be the Arctic, sub-Saharan Africa, small islands, and the mega-deltas. The poor, young children and the elderly will be those segments of the population to suffer most from climate change.

Concerning Europe, AR4 provides for the first time evidence of wide-ranging impacts in the form of the retreat of glaciers, lengthening of the growing season, shift in species ranges, heat waves etc. and forecasts that climate-related hazards will most likely increase, with more winter floods in maritime regions, flash floods throughout Europe, and increased sea-storm risks for 2.5 million people living in coastal areas. It is expected that Europe's biodiversity will be substantially affected by climate change with a large percentage of European flora likely to become vulnerable, endangered or extinct by the end of this century (e.g. up to 60% of Alpine plants are estimated to be at risk), also because options for adaptation are likely to be limited for many organisms and ecosystems. Water stress will increase over central and southern Europe and will affect more people living in river basins under high water stress. All this will pose challenges to many economic sectors. For instance, agriculture will have to cope with increasing water demands in southern Europe, peak electricity demand is likely to shift in some regions from winter to summer months, and reduced snow cover will make skiing problematic in a number of mountain areas.

A significant part of those impacts could be avoided if the global temperature increase above the pre-industrial level could be maintained below 2°C, which would need, according to the IPCC, global CO_2 emission reductions of the order of 50 to 85% by 2050 compared to 2000, and even stronger reductions for industrialised countries.

Professor van Ypersele concluded that appropriate mitigation measures were essential to prevent the avoidable impacts, but that in any case adaptation would be necessary to address those that cannot be avoided.

The role of soil organic matter in the global carbon cycle

Professor Rattan Lal, Ohio University, Carbon Management and Sequestration Center, Columbus, Ohio, USA

Professor Lal reminded the audience of some facts and figures concerning our 'carbon civilisation'. Global energy demand increased from 220 EJ[3] in 1970 to 428 EJ in 2001, and is projected to increase to 660 EJ by 2025. The price of oil increased from $25/barrel in 2000 to $135/barrel in 2008. Increases in energy demand and oil prices have a strong impact on atmospheric levels of carbon dioxide, which have increased from 280 parts per million (ppm) in the pre-industrial era to 385 ppm in 2008, and on world food insecurity, which is affecting about 1 billion people globally and increasing.

1) The full presentations are available at http://ec.europa.eu/environment/soil/conf_en.htm.
2) http://www.ipcc.ch/ipccreports/ar4-syr.htm.
3) EJ (exajoule) = 10^{18} J.

Carbon sequestration in soil and terrestrial ecosystems can contribute to climate change mitigation and also promote food security by enhancing agronomic production and input efficiency. The adoption of recommended management practices (e.g. no-till in conjunction with mulching and cover cropping, integrated nutrient management to create a positive nutrient budget, use of biochar, complex crop rotations, and water harvesting and recycling with drip/furrow irrigation) can sequester carbon in soil at a rate of 200 to 1 000 kg/ha/y with a total potential of 1 billion tonnes of carbon per year in agricultural soils (between 70 and 190 million tonnes for western Europe). The total carbon sink capacity of terrestrial ecosystems can offset about 50 ppm of atmospheric carbon dioxide.

Removal of crop residues for biofuel can adversely impact soil quality and create a large soil carbon debt. Rather than using crop residues, the conversion of degraded and agriculturally marginal soils to energy plantation (e.g. switch grass, miscanthus, poplar, willow), and growing algae and cyanobacteria in bioreactors are possible strategies to produce biomass for biofuel production.

Restoring degraded and desertified soils through carbon sequestration is also essential to improve soil quality and increase agronomic production especially in sub-Saharan Africa and South Asia. Increasing the soil organic carbon pool by 1 000 t C/ha/y can enhance food production in sub-Saharan Africa by 3.3 to 5.4 million tonnes per year for food grains and 3.0 to 6.2 million tonnes per year for roots and tubers.

However, poor farmers and small land-holders (< 2 ha) can neither afford the prohibitively expensive inputs nor can they be sure of their effectiveness. Paying farmers for ecosystem services (e.g. carbon sequestration, water quality improvement, biodiversity enhancements) can create the much needed income streams to facilitate the adoption of recommended practices. The carbon market may reach $1 trillion by 2020 and must be promoted to pay for ecosystem services provided by farmers in sub-Saharan Africa and South Asia. Professor Lal thought this to be a win-win-win option.

UK losses of soil carbon – due to climate change?

Mrs Pat H. Bellamy, National Soil Resources Institute, Cranfield University, United Kingdom

Mrs Bellamy presented the context of her research. More than twice as much carbon is held in soils as in vegetation or the atmosphere, and changes in soil carbon content can have a large effect on the global carbon budget. The possibility that climate change is being reinforced by increased carbon dioxide emissions from soils owing to rising temperature is the subject of a continuing debate. But evidence for the suggested feedback mechanism has to date come solely from small-scale laboratory and field experiments and modelling studies.

Turning to the results of her research, Mrs Bellamy said that data from the National Soil Inventory of England and Wales obtained between 1978 and 2003 showed that carbon was lost from soils across England and Wales over the survey period at a mean rate of 0.6% per year (relative to existing soil carbon content). Scaling up the results to the United Kingdom, it was estimated that 13 million tonnes of carbon were lost every year from British soils. As a comparison, industrial carbon emissions in the United Kingdom had fallen by no more than 13 million tonnes since 1990. It was found that the relative rate of carbon loss increased with soil carbon content and was more than 2% per year in soils with carbon contents greater than 100 g/kg. The relationship between rate of carbon loss and carbon content is irrespective of land use, suggesting a link to climate change. These findings indicate that losses of soil carbon in England and Wales – and by inference in other temperate regions – are likely to be offsetting the absorption of carbon by terrestrial sinks.

To investigate the possible causes of the measured losses of soil carbon, simple models of soil carbon turnover were applied to evaluate alternative explanations for the observed trends. It was found that neither changes in decomposition resulting from the effects of climate change on soil temperature and moisture, nor changes in carbon input from vegetation, could account on their own for the overall trends. Regarding other explanations,

results so far indicate that past changes in land use and management have probably been dominant. The climate change signal, such as it is, is masked by these other changes.

Mrs Bellamy concluded by saying that more sophisticated models of carbon change were currently being developed to represent the whole range of soils in England and Wales. These models were being validated using the National Soil Inventory data and would allow a more precise estimation of the contribution of climate change to the change in soil carbon observed in the National Soil Inventory data.

Emissions from peat soils

Dr Jari Liski, Finnish Environment Institute (SYKE), Research Programme for Global Change, Helsinki, Finland

Dr Liski presented some figures concerning the role of peatlands from the climate perspective. Peatlands contain between 15 and 30% of all soil carbon (between 250 and 460 billion tonnes compared to a global soil carbon pool of 2 300 billion tonnes), which is equivalent to 30-60% of the carbon present in the atmosphere (760 billion tonnes) as carbon dioxide. In terms of emissions, peatlands are responsible for 20-40% of global methane emissions (70-90% of natural emissions), whereas nitrous oxide emissions are usually limited (except for nutrient-rich fens). Given their large carbon pool, a hypothetical loss of 1% of peat carbon would equal 30-60% of annual fossil carbon emissions. Almost half of European peatlands is still in a natural condition, while the other half has been converted to agriculture (50%), forestry (30%), extraction (10%), and urbanisation (10%).

In the EU-25, peatlands emit 21 million tonnes of carbon as carbon dioxide equivalent, which corresponds to about 1-2% of European anthropogenic greenhouse gas emissions, amounting to around 1.4 billion tonnes of carbon. Although peatlands are net emitters in each Member State, emissions depend on peatland type and their use in each Member State. As a general rule, bogs (nutrient-poor peatland) have the lowest emissions if used for forestry or are restored and the highest emissions if abandoned after harvest, put under permanent grass or used as arable land. Fens (nutrient-rich peatland) have the lowest emissions when restored or used for forestry and the highest under grassland or arable land.

Dr Liski concluded his presentation by stating that despite their emissions, natural peatlands should be protected and maintained to avoid large carbon emissions to the atmosphere. Moreover, it should be borne in mind that the conversion of natural peatlands to other land uses has long-term impacts that need to be considered over an appropriate (long) time-frame when estimating the consequences.

Changes in soil organic matter in relation to land use and agricultural practices

Dr Dominique Arrouays, Directeur Unité Infosol, INRA, Orléans, France

Dr Arrouays outlined the four ways in which carbon can be managed, starting with the fixation of carbon by plants through photosynthesis, the use of this carbon by vegetation, the production of litter when plants die, and finally the soil carbon stock.

In the case of France, the soil carbon stock has been estimated at 3.1 billion tonnes in the 0-30 cm layer with large variations depending on land cover, ranging from 30 tonnes of carbon per hectare for vineyards and orchards to more than 90 tonnes per hectare for mountain grassland and peatland.

Concerning land cover changes, Dr Arrouays drew the attention of the audience to the fact that the conversion of arable land to grassland or forestry increased carbon stocks, whereas conversion the other way round decreased soil carbon twice as rapidly as the accumulation resulting from afforestation. As for other factors influencing soil carbon stocks, reduced or no tillage, continuous soil cover, temporary vs permanent grassland, and potential variations in soil and climate were particularly relevant. Some inherent soil properties, such as clay content, were also main controlling factors in carbon stabilisation.

Summing up, Dr Arrouays stated that managing soil carbon stocks was possible, but that preserving existing stocks was more important than creating new stocks, as the extension over space and the sustainability over time of some practices leading to soil carbon accumulation were limited. Moreover, soil as a carbon sink was only a finite answer to mitigation.

Emissions due to land use changes in Brazil

Professor Carlos C. Cerri, CENA-USP, Laboratório de Biogeoquímica Ambiental, Piracicaba, Brazil

Professor Cerri presented the data forwarded to the United Nations Framework Convention to Combat Climate Change (UNFCCC) on Brazilian greenhouse gas emissions, with particular emphasis on the soil contribution. Brazilian soils are an important carbon pool, containing about 36 billion tonnes of carbon in the 0-30 cm layer, approximately 5% of the world soil carbon stock.

Data for 1994 showed that land use, land use changes and forestry (LULUCF) accounted for 75% of carbon dioxide emissions (with about 68% attributed to deforestation and 7% to soil carbon losses), 14% of methane emissions and 2% of nitrous oxide emissions. These figures set apart Brazil from industrialised countries, because only 25% of carbon dioxide emissions were due to fossil fuel combustion compared to 78% at global level. Mean annual emissions from Brazilian soils in the period 1975-1995 were estimated to have been around 46.4 million tonnes of carbon dioxide (equivalent to 12.6 million tonnes of carbon).

Professor Cerri thought that, thanks to changes in agricultural practices (no tillage for cultivation, no burning for harvesting, and better management of degraded land), Brazilian soils may now be a net sink.

The role of agricultural practices in keeping or increasing soil organic matter

Professor Peter Smith, Lead Author of the IPCC Good Practice Guidelines 2006, Professor of Soils and Global Change, University of Aberdeen, United Kingdom

Professor Smith presented key figures concerning the global carbon cycle and emphasised that soils can increase their amount of organic carbon or lose it depending on the land management practices adopted. Soil carbon sequestration can be achieved by increasing inputs (e.g. through the use of organic amendments, residue management and increased plant carbon input) or by reducing the losses, for instance by restoring and rewetting drained peatlands.

Agricultural lands take up about 40-50% of the Earth's land surface. Considering all gases, the global technical mitigation potential for agriculture (excluding fossil fuel offsets from biomass) by 2030 is estimated to be about 5.5-6 billion tonnes of carbon dioxide equivalent per year. Economic potentials are estimated to be 1.5-1.6, 2.5-2.7, and 3.1-3.3 billion tonnes of carbon dioxide equivalent per year at carbon prices of up to $20, $50 and $100 per tonne of carbon dioxide equivalent, respectively.

However, even at $100 per tonne of carbon dioxide, the sequestration potential will not exceed 1 billion tonnes of carbon per year. As atmospheric carbon dioxide is increasing at a rate of 3.2 billion tonnes of carbon per year, soil sequestration can thus mitigate less than one third of this increase or less than one seventh of carbon emissions due to fossil fuel burning.

Nevertheless, according to IPCC scenarios, the world is right now at a critical point that will determine the trajectory of temperature change up to 2100. All the possible mitigation measures available should be exploited. Despite the fact that soil carbon sequestration is of limited duration (due to sink saturation) and that the response of soil carbon sinks to future climate change remains uncertain, soil carbon sequestration is a globally significant climate mitigation measure, also because agricultural/soil-carbon management strategies

4) http://www.global-greenhouse-warming.com/global-carbon-cycle.html.

are cost-competitive with mitigation measures in other sectors.

Professor Smith concluded by stating that carbon sequestration through improved soil management had a key role to play in climate mitigation and needed to be applied very soon in order for it to play a role in avoiding dangerous climate change.

Evaluation of the potential of selected measures to reduce carbon emissions and sequester carbon in European soils

Dr Annette Freibauer, Co-ordinator of the EU CarboEurope-Integrated Project, Max-Planck-Institute for Biogeochemistry, Jena, Germany

Dr Freibauer started her presentation by reminding everyone that to assess effective mitigation options the full greenhouse gas budget needed to be considered, as focusing only on carbon dioxide would miss at least half of the contribution of European soils to climate change.

Functionally, the European biosphere is comparable with a sponge that is far from being saturated. Some pores are currently filling up, while others are leaking carbon at a rate almost equal to that of the carbon being added, resulting in only minor changes in the total content of the sponge. To fill up the sponge at a faster rate, i.e. enhance the net carbon sink, management policies should focus on three aspects: a) ensuring that the pores that are currently filling up continue to fill up (managed forests and grasslands); b) reducing losses from leaking pores (drained peatlands); and c) reducing the pressure on the pores that are almost saturated (mitigation options for arable soils).

Four strategies for improving the soil carbon balance should be pursued. Firstly, emissions of carbon dioxide, methane and nitrous oxide should be reduced. This is mostly relevant for drained peatlands and intensively managed agricultural lands. Secondly, carbon should be sequestered permanently. Stable humus currently accounts for only 1% of the carbon input to the soil, unless complex recalcitrant organic substances (e.g. charcoal) are added. Thirdly, fertility should be enhanced by putting more organic residues into the soil. Finally, soil resilience should be ensured by improving water holding capacity and erosion control.

Carbon sequestration by switching from annual crops to perennials or by introducing more organic amendments (and doing this more effectively), runs completely counter to current trends from grassland to cropland and the growing demand for biomass/bioenergy. Perennial crops for renewable material and biomass could sequester additional soil carbon. This opportunity is currently missed by farmers' preference for annual crops. Specific incentives to grow perennials are urgently needed.

Greenhouse gas emissions from soil can be reduced. Most urgently, nitrous oxide from agricultural soils and carbon dioxide and nitrous oxide emissions from drained peatlands need to be addressed. Priorities for climate change mitigation should focus on hotspot regions and soil types where the emissions are highest and reductions therefore measurable.

Despite the fact that there were still open questions and research needs, Dr Freibauer considered that three measures to enhance soil resilience and help mitigate climate change should be promoted at European level as a priority. Firstly, the restoration of drained peatlands, which had a theoretical mitigation potential of 50-100 million tonnes of carbon dioxide equivalent per year, i.e. 1 to 2% of emissions in the EU-25. Moreover, peatland restoration had also strong synergies with biodiversity conservation and water management. Secondly, advances in fertiliser use in nitrous oxide-sensitive regions, although the effect was not yet quantifiable at this stage. Thirdly, incentives for using perennials for the production of biomass and bioenergy.

Summary of panel members' contributions

Mrs Nathalie Kosciusko-Morizet, Secretary of State for Ecology, France (contribution recorded on 4 June 2008)

In her recorded statement, Mrs Kosciusko-Morizet thanked Mr Dimas for organising the conference, which she thought most timely and appropriate. Timely because the climate change and energy package presented by the Commission in January 2008 would be a priority for the French Presidency. Appropriate because soil should be included as a mandatory accounting category for industrialised countries in any post-Kyoto agreement.

The conference would therefore be instrumental in presenting important scientific data informing that discussion. Despite existing methodological problems, the contribution of all greenhouse gases linked with soil and agricultural activities, including nitrous oxide and methane, should be considered. In this context, the CAP should address climate change issues to a greater extent and better enable farmers to take climate change considerations fully into account.

She went on to say that the French Presidency was eagerly awaiting the European Commission's adoption of the White Paper on adapting to climate change in November 2008, which would be one of its priorities. She added that the proposal for a Soil Framework Directive would feature in the calendar of the French Presidency, because the Directive would make a contribution to carbon storage in soils.

Mr Janez Podobnik, Minister of the Environment and Spatial Planning, Slovenia

Mr Podobnik remarked that in Slovenia, too, there was growing awareness of the importance of organic matter in soil. However, given the rise in average temperature over recent years, the higher frequency of drought, and agricultural production methods, it was estimated that the organic matter content of soil on intensively farmed land was falling.

In order to understand the complex relationship between human activities and their consequences for the environment, it was necessary to have high quality, comparable and compatible data. Good-quality assessments of trends could be obtained from permanent and systematic monitoring of organic matter on the same land with the same type of soil use. This should be done on a comparable basis at Community level.

Mr Podobnik wondered whether it would not be wise to consider including permanent monitoring of reference areas and measures for appropriate soil management — to preserve and increase the capacity of soil to capture carbon dioxide — in Community measures to reduce the impact of climate change. He would also favour going a step further and trying to harmonise the target values for organic matter content in soil, nevertheless taking account of the diversity of natural conditions across the Community.

In order to increase the quantity of organic matter in the soil, it was necessary to ensure sustainable practice on the part of all soil users, and in particular to encourage agriculture and forestry to engage in sustainable practice, and to advocate rational planning of land use that reduces the capacity of soil to capture carbon dioxide by as little as possible.

In the past, Europe had made a decisive contribution to improving the quality of air and of surface and ground water. Mr Podobnik thought that Europe must adopt a similar approach to soil protection. The activities set out in the Soil Thematic Strategy and the proposal for a Soil Framework Directive were appropriate and necessary,

and Slovenia was in favour of continuing negotiations until agreement was reached on the adoption of the proposal.

Mr Podobnik concluded by saying that in Europe there was a need for systematic and harmonised monitoring of the quantity of organic matter in soil. In addition, sustainable forms of soil use should be supported in order to accelerate the capture of carbon dioxide in soil.

Mrs Sveinbjarnardóttir, Minister for the Environment, Iceland

Mrs Sveinbjarnardóttir began by outlining Iceland's role in the development and implementation of United Nations conventions on the environment.

Iceland had a long history of severe land degradation and desertification and was the home of the longest-standing organised efforts to combat desertification and restore natural resources in the world. Currently, 40% of Iceland was covered by desert, and a large proportion of the remaining area was severely degraded. Forests covered only 1.2% of the country. It was among the most severely degraded countries in the world. However, Iceland had recorded remarkable achievements in halting desertification and restoring fertility and ecosystem services in the last ten decades and had celebrated 100 years of such activities in 2007 with a number of local and international events.

The link between the Convention to Combat Desertification (UNCCD), the Framework Convention to Combat Climate Change (UNFCCC), the Convention on Biodiversity (UNCBD), and food security, especially in less developed countries, was stressed. A common thread in all of the conventions was the importance of soils and ecosystem services. Carbon in soils was the fundamental ingredient of soil fertility and of the role of soils in ecosystem services such as water retention. It was important to note that there was more carbon stored in soils than in vegetation and the atmosphere combined; soils contained 82% of the active terrestrial carbon. A substantial proportion of today's greenhouse gases in the atmosphere originated from carbon and nitrogen compounds from soils, due to over-exploitation of soil resources. Further climatic changes might accelerate the release of carbon from soils, especially from the Arctic.

However, Mrs Sveinbjarnardóttir stressed that a significant part of atmospheric greenhouse gases could be returned to soils and ecosystems, and by doing so, increase their fertility and biodiversity and promote food production. Mitigating climate change through carbon sequestration by trees had received disproportionate attention in comparison, bearing in mind the possible benefits of carbon sequestration and food security associated with restoring degraded lands. This bias, one might call it, was evident in the Kyoto Protocol, and in the makeup of many scientific groups dealing with carbon sequestration, and in many international decisions and negotiation outcomes. Trees were important, and so was the task of saving forests and sequestering carbon in new ones. There was, however, an urgent need to observe and understand the broader picture: the soil, and the linkage between returning carbon to soil from the atmosphere, increasing biodiversity, increasing food production, and ensuring that the Earth's ecosystems worked. Iceland was using land restoration, and in particular that of soils, to balance greenhouse gas emissions under the United Nations Framework Convention to Combat Climate Change.

In conclusion, Mrs Sveinbjarnardóttir stressed the need to strengthen the synergies between the international conventions for the benefit of the global environment, the restoration of degraded ecosystems, sustainable use of the Earth's resources, and securing food for mankind.

Mr Humberto Rosa, Secretary of State for Environment, Portugal

Mr Rosa began his intervention by stressing that soil could make a significant difference not only to climate change, but also to avoiding desertification and to promoting biodiversity and ecosystem services, which meant that soil management was closely linked to all these areas.

In terms of legal protection and political focus, soil had been a neglected natural resource, and yet it was a complex entity, a rich and diverse ecosystem slowly accumulating over millennia, suffering from pollution and degradation processes. It formed the basis for sustaining other values and resources, such as the metabolic capacity of the ecosystems that overlay it. In spite of this, it was not being given the same consideration as forests or fish stocks, and it did not have the charisma of endangered species and ecosystems. Soil tended to be taken for granted, as if it was eternal.

Recalling several cases of societies in human civilisation which, according to today's knowledge, had declined or collapsed due to environmental factors or unsustainable action (e.g. in Yucatan, on several Pacific Islands, and in Greenland), Mr Rosa stressed that these factors were generally related to deforestation, soil loss or degradation. When arriving in a new environment, humans had shown an invariable trend to corrupt natural capital, including soils, without much awareness of the consequences of their actions, and often ended up suffering the costs.

There was now knowledge and awareness that the world was our 'island', and that there were no other places to which one could emigrate to avoid global environmental problems such as climate change. We were all aware of the consequences of our actions and therefore there was no longer any excuse for not addressing environmental problems. Mr Rosa drew attention to the worrying worldwide acceleration of soil degradation, namely in terms of erosion, salinisation, sealing and compaction, and stressed the need to reform or adapt land use practices to prevent this acceleration and, alternatively, to foster practices that actually promoted soil preservation, thereby contributing to carbon dioxide storage, maintenance of biodiversity and water retention.

Pointing to good examples of agricultural practices, Mr Rosa reported that recently he had witnessed the results of planting perennial biodiverse grasslands in Mediterranean ecosystems. By applying an adequate mix of seeds, including nitrogen-fixing plants, quite astonishing multiple-win results could be achieved, such as (i) increasing productivity (the number of sheep per hectare had risen from one to eight), (ii) increasing soil organic matter from 0.2% per year to 10% per year, (iii) capturing 5 tonnes of carbon dioxide per hectare per year, (iv) abandoning the use of chemical fertilisers, (v) increasing biodiversity and (vi) reducing the risks and consequences of forest fires.

At EU level, not enough was being done about soil protection. Although different Community policies contributed to soil protection, particularly environment and agriculture policy, they fell a long way short of addressing the threats to soil. Beyond climate change, soil degradation had a substantial impact on other areas of common interest to the Community, such as water, human health, nature and biodiversity protection, and food safety. For these reasons, Mr Rosa clearly stated the need for an EU Directive to protect and preserve soil and called on the French Presidency of the Council to resume negotiations and pursue a political agreement on this issue.

Addressing the issue of carbon capture and storage (CCS), Mr Rosa referred to it as a useful tool of a transitional nature; however, the world would need ecological engineering to redistribute carbon dioxide into compartments other than the atmosphere and degraded land had to be restored in order to provide ecosystem services and contribute to carbon dioxide sequestration, in particular through reforestation.

Addressing the increasing reduction of organic matter in the soil, Mr Rosa pointed out that in contrast there was an excess of organic matter where it was not wanted, such as in urban waste, sewage and manure, and challenged the participants to consider ways of managing waste in order to return organic matter to the soil in a convenient way. He went on to say that the participants should reflect on the possibility of incorporating soil carbon units in the Kyoto Protocol along the same lines as those for forest sequestration, while recognising that this last suggestion would be a significant test to monitoring methodologies.

In conclusion, Mr Rosa expressed both the wish and the conviction that the EU should lead and show the way on soil protection and soil use for climate change mitigation, taking on a major role in helping to prevent the degradation of natural capital, in the form of soil, and instead restoring soil for the sake of increased ecosystem services.

Mr Vittorio Prodi, Rapporteur on the Soil Thematic Strategy and Vice-Chairman of the Temporary Committee on Climate Change, European Parliament, Brussels

Mr Prodi underlined the importance of a systemic approach in dealing with soil and climate. It was a well known fact that with climate change, Europe would experience more intense and longer periods of drought, and rainfall patterns would be disrupted, resulting in less snow but more flooding and erosion. To address these problems it was crucial to ensure that water was retained where it fell, so as to stop rivers from overflowing and replenish water tables. This meant that we must look after the land and maintain it well, bearing in mind the systemic role that soil performed in terms of carbon sink.

On climate change, there was a need to adapt to its effects and adopt appropriate mitigation measures. Revenues from the ETS[5] should be partially dedicated to managing soils and adapting to climate change. Emissions nowadays averaged 5 tonnes of carbon dioxide per person per year. Cutting that amount to 1 tonne per person by 2050 was necessary to avoid the catastrophic effects of increased carbon dioxide concentration in the atmosphere.

The Soil Framework Directive had, in this context, an important role to play, because it was based on a systemic approach to maintaining and improving soil quality. In this way soils would be made more resilient against desertification and their potential to act as a carbon sink would be fully exploited.

Mr Prodi concluded by saying that some Member States took the view that soil did not move and that, therefore, individual Member States should maintain their sovereignty over it. In reality, soil quality and soil degradation were of a transnational nature. He had fought and would continue fighting in the European Parliament for the Soil Framework Directive because of the importance of healthy soils for mankind.

Mr Staffan Nilsson, Rapporteur on the Soil Thematic Strategy, European Economic and Social Committee, Brussels

Mr Nilsson noted that the positive opinion of the European Economic and Social Committee, an advisory body of the European Institutions, on the Soil Thematic Strategy and on the proposal for a Soil Framework Directive had been adopted almost unanimously (only two votes against). That had not been an easy outcome to secure, because certain Member States and stakeholders (e.g., farmers' organisations) would only support a non-binding strategy.

5) Editor's Note: ETS stands for the European Union Greenhouse Gas Emission Trading Scheme. More information at http://ec.europa.eu/environment/climat/emission/index_en.htm.

When the European Commission had presented the legislative proposal, great emphasis had been put on identifying soil degradation due to bad agricultural practices and contamination. Now it appeared that there was also a strong link with climate change that should have been better communicated.

Soil quality and soil carbon were also linked with the use of sewage sludge. Despite a lengthy stakeholder consultation, the European Commission had failed to present a proposal for revision of the existing Sewage Sludge Directive 86/278/EEC. This Directive contained limits on heavy metals that were not enough strict to reassure sludge users. Mr Nilsson stated that he would maintain his opposition to the use of sludge in agriculture until the limits in the Directive were considerably lowered.

Turning to the health check on the Common Agricultural Policy, Mr Nilsson held the view that the increase in funding for agri-environment measures co-financed by Member States would increase year by year through modulation. Thus, there would be more scope for promoting and funding environmental programmes to protect soil and increase carbon stocks.

As a final remark, Mr Nilsson stated that the link between soil and climate change highlighted by the conference should convince everyone of the need to go forward with the Soil Framework Directive.

Final Remarks

Mr Jos Delbeke,
Deputy Director-General, Environment Directorate-General, European Commission

Mr Chairman,

Ladies and gentlemen,

Following today's most thoughtful scientific presentations and the lively exchange of views among the distinguished members of the panel that we have heard, let me attempt to draw some conclusions the Commission would take out of today's conference.

Firstly, there has been agreement on the fact that soil is part of the climate change problem, but can also be part of the solution. To what extent soil is emitting greenhouse gases and to what extent the processes leading to these emissions can be reduced will need further work to be better understood and quantified. But the general picture is clear – through the adoption of appropriate soil management practices, maintaining carbon in soil and – if at all possible – increasing it can contribute to offsetting fossil fuel emissions.

According to Professor Lal, total carbon sink capacity of terrestrial ecosystems is equivalent to off-setting about 50 parts per million of atmospheric carbon dioxide. Although the carbon sequestration potential from soil may only be one seventh of fossil fuel emissions, Professor Smith has presented a strong argument in favour of soil sequestration, and soil sequestration now. At the same time, Dr Liski and Dr Freibauer have powerfully underlined the importance of natural peatlands as both a repository of carbon but also as a potential source of methane and nitrous oxide – not to mention their role in terms of water filtration and their rich biodiversity. In their views, protecting peatlands and promoting their restoration where already drained would constitute the most urgent action to undertake for reducing the huge greenhouse gas emissions from peat soils. Along this line, Dr Arrouays has pointed out that preserving existing carbon stocks might be more important than trying to create new ones.

All this points in the direction of the need to step up our efforts at EU level for ensuring that organic matter is kept in our soils and that best practices are progressively introduced to minimise, in particular, nitrous oxide emissions from agriculture. The figures mentioned by Professor Cerri for Brazil are particularly reassuring, as it seems that negative trends can indeed be changed.

In any case, we cannot afford to disregard the role that soil plays in the global carbon and nitrogen cycles!

And this leads me to the second message we will take out from the conference.

Albeit with significant uncertainties, we know that European soils are losing carbon, and – to a certain extent – we are able to estimate the amount of this loss. However, we are far from the situation for the United Kingdom presented by Mrs Bellamy, where a soil monitoring system has been in place for decades. I think there is a need to start working all together – European Commission, Member States, research community – for adopting a common legislative framework for soil protection in the EU that will allow us to gather more information and therefore manage the soil carbon pool in the most efficient way.

The relationship between soil and climate change is an issue of global consequences and has enormous transboundary impacts. Hence the progress done in soil protection in one Member States definitely has consequences for another Member State. Thus, there is an urgency to act at EU level.

Not surprisingly, I will here echo what Mr Dimas already said this morning – the Commission has already done its job in putting forward a proposal for a Soil Framework Directive! This proposal will lead Member States to identify where soil organic matter decline is happening in their territory. This will be the first step for building a knowledge base necessary for addressing the important challenge of climate change in relation to soil.

What Mr Prodi has said today has clearly shown the commitment of the European Parliament to go forward with the proposal. It has the support of civil society, here represented by Mr Nilsson of the European Economic and Social Committee. Twenty two Member States – including Slovenia and Portugal, which made enormous efforts for an agreement during its Presidency – are behind it. We now need all Member States to acknowledge the need to tackle soil protection at EU level. The blocking minority in the Council should realise the wider benefit that the Soil Framework Directive will bring, also in terms of adapting our economies to climate change. In this context, I take note with satisfaction of the commitment made by the French Secretary of State, Mrs Kosciusko-Morizet, to continue the discussions on the proposal under the French Presidency.

Which brings me to the third message that the Commission will take out of this conference – the need to adapt to climate change and the role that soil can play in it.

Professor van Ypersele earlier this morning has very forcefully reminded us of the conclusions of the Intergovernmental Panel on Climate Change concerning Europe. Climate-related hazards will increase and climate change is likely to magnify regional differences. Water stresses will exacerbate desertification risks also in areas currently not subject to it. The issue is therefore not *if* but *how* we are going to adapt to an increase in average temperatures, changes in rainfall patterns, increased flooding risks, longer droughts, and so on.

I believe that what we have heard today demonstrates that soil organic matter has a big role to play, a role that goes often unnoticed. Professor Lal has attempted to put a figure on such a role, in terms of the societal value of soil carbon. While we could discuss endlessly about the assumptions used to come up with such a figure, it is evident that a healthy soil with an optimum structure will be more resilient to negative climatic conditions. Which is the point also made by Minister Sveinbjarnardóttir during the panel discussion.

Ladies and gentlemen,

Let me close my intervention with three important points.

I trust that today's conference will be instrumental in raising the awareness about soil and its relationship with climate change, and that you will become ambassadors of this relationship in your countries.

I trust that the presentations and the discussions you have heard will be helpful in shaping your contribution – at whatever level that might be – for better soil organic matter management across Europe.

Finally, as we need to achieve better soil organic matter management, I trust that you fully share with me the urgency of adopting legislation on soil protection at EU level – and make your voice heard back home!

On a more mundane note, after the closing remarks by Mr Gnacadja, you are all invited to a drink reception, courtesy of the European Commission, to complete this fruitful but long day.

Thank you for your attention.

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