The European Soil Bureau

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Summary

The European Soil Bureau (ESB), located at the Joint Research Centre (JRC), Ispra (I), was created in 1996 as a network of national soil science institutions. Its main tasks are to collect, harmonise, organise and distribute soil information for Europe. This paper describes the history, background and current work programme of the Bureau. Activities are currently organised through five working groups: the 1:1,000,000 European soil database group; the Information Access Working Group (IAWG); the 1:250,000 working group; the soil erosion risk assessment working group; and the soil analytical methods working group.

The ESB is now experiencing a surge in the demand for soil information in Europe, for addressing a number of environmental problems and questions. These include: leaching of agrochemicals, deposition of heavy metals, disposal of waste (agricultural, domestic and industrial), degradation of soil structure (through loss of organic matter, salinisation and subsoil compaction), risk of erosion (by water and wind), immobilisation of radionuclides, supply of water at catchment level, assessing the suitability (and sustainability) for traditional and alternative crops, and estimation of soil stability.

There have been recent calls for a European Soil Forum among high-level officials and decision-makers to develop a 'common ground' for soil protection policies in Europe. To meet this challenge, the European Soil Bureau must enlarge its scope and improve the current soil databases. These were designed primarily to respond to issues of soil fertility in a 'climate' that was striving to make European agriculture more productive. Attention is now focussing on the relationship between soil and the quality of agricultural products, and the impact of agriculture (and other human activities) on soils.

Introduction

The European Soil Bureau (ESB) was created in 1996, as a network of national soil science institutions, managed through a permanent Secretariat located at the Joint Research Centre (JRC), Ispra, Italy. It is part of the Agriculture and Regional Information Systems Unit (ARIS) of the Space Applications Institute (SAI), one of four institutes at the JRC's Ispra site (Meyer-Roux and Montanarella, 1998).

The ESB's aim is to carry out scientific and technical work programmes in order to collect, harmonise organise and distribute soil information relevant to Community policies, to a number of Directorates General (DG's), to the European Environment Agency (EEA) and to individual Institutions of the EU Member States. Its current organisation is represented in Figure 1.

The origins of the ESB go back more than a decade and are inextricably linked to the compilation of a European Soil Map and associated attribute databases. An EC Soil Map was produced at 1:1,000,000 scale in the 1970s by a loose network of academic soil scientists. The most important contributors to the map are listed below.

Belgium: *J. Ameryckx, A. Louis, R. Maréchal, R. Tavernier*; Denmark: *K. Rasmussen;* France: *J. Dupuis, M. Jamagne, A. Mori, E. Servat;* Germany: *E. Mückenhausen;* Greece: *A. Koutalos, N. Yassoglou;* Irish Republic: *M. Gardiner, J. Lee;* Italy: *F. Mancini, R. Salandin;* Luxembourg: *A. Puraye, J. Wagener;* Netherlands: *H. De Bakker, J. Pons, J. Schelling, R. Van der Schans;* Portugal: *J. Carvalho Cardoso;* Spain: *A. Guerra, F. Monturiol;* United Kingdom: *B. Avery, R. Glentworth, R. Grant;* FAO: *R. Dudal;* CEC: *A. Cole, J. Gillot, A. Prendergast;* Advisors: *K. Beek, S. Lunt, G. Smith, C. Sys,;* Computerisation: *H.B. Madsen, A.M. Norr, S.W. Platou*

The 'digital age' for European soil information effectively began in 1982 when a 'Computerisation of Land Data Group' (CLDG) was established by

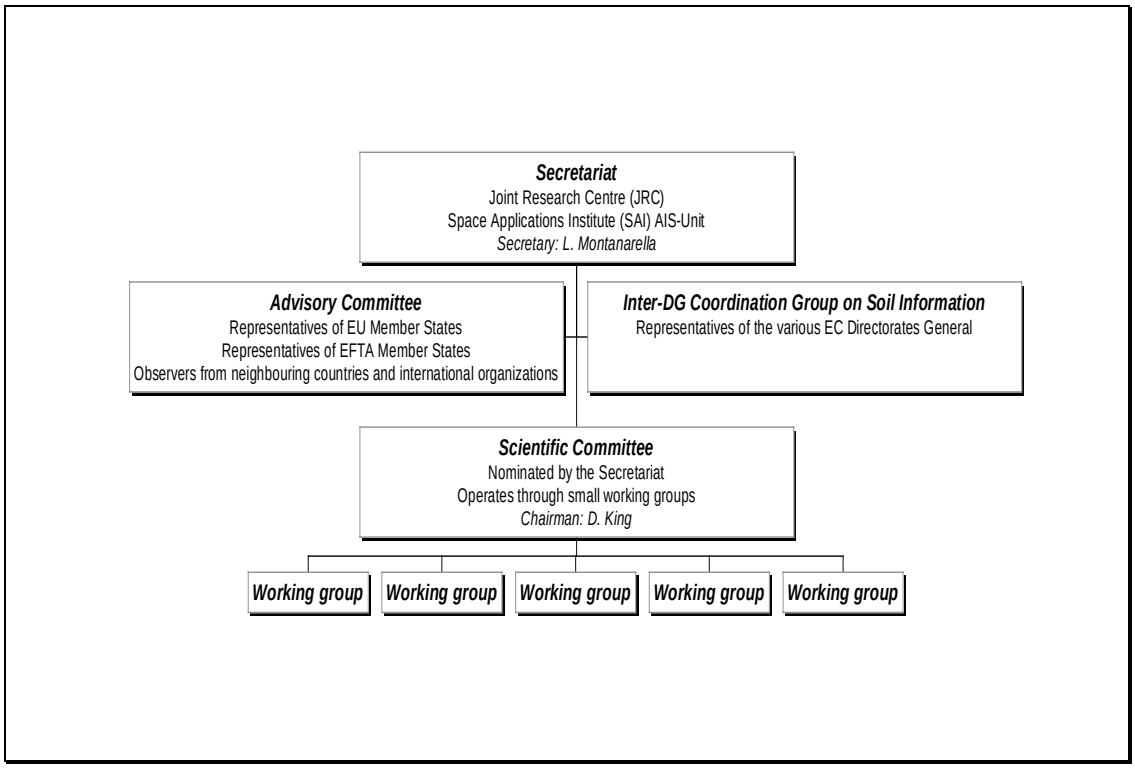


Figure 1: Current organisation of the European Soil Bureau.

DGVI, comprising representatives of the main centres of expertise within the EC at that time. The work of the CLDG was executed under the guidance of the Land and Water Use Steering Committee of DGVI.

The first meeting of the group was in Ispra in 1982. Draft proposals for the compilation of a Land Data Catalogue for the whole of the EC were presented at the second CLDG meeting in Montpellier (1983).

In 1985, the EC Soil Map was finally published in 7 sheets and covered the EC-12 countries (CEC, 1985). It was printed on a base map provided by the UK Military Authorities with a topographical component compiled from the ONC-map series (Operational Navigational Chart Series).

The base map comprised the geodetic constants of a Lambert conformal conical projection. A manual, describing the soil map units and their contents, was also published with the maps. This task was completed in parallel with the work of the CLDG but provided a key foundation for the future of digital European Soil Data.

The group continued to meet annually until 1988 and it was responsible for a number of initiatives with respect to European soil and land data:

1. Digitisation of the EC Soil Map (Platou *et al*,. 1989)
2. Compilation of an EC Land Data Catalogue (Nørr, 1986)
3. Proceedings of the Bonn (1986) and Pisa (1987) meetings (Jones and Biagi, 1989)
4. Proceedings of the Wageningen meeting (1988) on applications of the digital EC Soil Map and climate data (van Lanen and Bregt, 1989)

In 1989, DGVI ceased funding the activities of the Computerisation of Land Data Group and a period of dormancy followed. However, there was still a need for such activities at a European level. The MARS Project at JRC needed information on the water holding capacities of European soils for input to a model (CGMS) that was under development for forecasting the yields of the main agricultural crops throughout the continent (Vossen and Meyer-Roux, 1995).

This lead in 1990 to the setting up of a Soil and GIS Support Group funded by the MARS Project (JRC). In the previous year (1989), a meeting of Heads of European Soil Surveys was held at Silsoe (UK) to review the activities connected with soil survey and data collection throughout Europe (Hodgson, 1991).

In addition to providing MARS with data on the water holding capacities of soils in Europe, the Soil and GIS Support Group began work on a number of fundamental database projects:

1. A major update of the EC Soil Geographical Database (the digital version of the published EC Soil Map) described by King *et al.* (1995b);
2. The compilation of a soil profile analytical database (Madsen, 1991, Madsen and Jones, 1995);
3. Development of a pedotransfer rules database (King *et al.,* 1994; van Ranst *et al.,* 1995).

As a result of its expanding activities, the Soil and GIS Support Group was renamed, in 1992, the Soils Information Focal Point (SIFP) with a work programme devised by a Soil Information System Development (SISD) Committee, under the chairmanship of Dr D. King (INRA, Orleans, Fr.). The Heads of Soil Surveys met again in December 1994, in Orleans. At this meeting (Le Bas and Jamagne, 1996), it became clear that the amount of soil survey and soil monitoring activity, being undertaken in the member states of the EU, had reduced significantly compared to 1989 (Hodgson, 1991).

In an effort to revive soil monitoring as an important research activity, a network of centres of excellence in soil hydrology was set up (in 1994) under the EU Human Capital and Mobility Programme. This began to produce data for computing pedotransfer functions for estimating the hydraulic properties of European soils (Bruand *et al.*, 1997).

At the Athens meeting of the SIFP in 1996, the European Soil Bureau (ESB) came into existence and the SISD evolved into the ESB Scientific Committee. Table 1 charts the meetings of the ESB and its predecessor organisations that have been associated with the computerisation of soil and land data in Europe. Much of the work undertaken by the Soil and GIS Support Group, the SIFP/SISD and the ESB (in its first year) is described in King *et al.* (1995a) and Heineke *et al.* (1998).

Table 1 Meetings on the computerisation of soil and land data in Europe

Date	Location	Organiser
1982	JRC Ispra, Italy	
1983	INRA, Montpellier, France	Dr Jean-Paul Legros
1984	Bureau of Land Data (ADK), Vejle-Copenhagen, Denmark	Dr Henrik Madsen
1985	Royal Institute of Chartered Surveyors and the Ministry of Agriculture, Fisheries and Food, London, UK	Mr Doug Fitch
1986	Ministry of Agriculture, Bonn, West Germany	Herr E C Lapple
1987	CNR Instituto Elaborazione Informazione, Pisa, Italy	Dr Benedetto Biagi
1988	Stiboka, Wageningen, The Netherlands	Dr Johan Bouma
1989	No meeting held	
1990	IRSA, JRC, Ispra, Italy	Dr Paul Vossen
1991	University of Ghent, Ghent, Belgium	Profs Tavernier, Van Ranst
1992	Madrid, Spain	Dr Juan Jose Ibanez
1993	Geographical Institute, University of Copenhagen, Copenhagen, Denmark	Prof. Henrik Madsen
1994	BGR Hannover, Germany	Dr Wolf Eckelmann
1995	FAO, Roma, Italy	Dr Freddy Nachtergaele
1996	University of Athens, Athens, Greece	Prof. Nicholas Yassoglou
1997	Regione Emilia Romagna, Bologna, Italy	Drs Nicola Filippi, Luca Montanarella
1998	No meeting held	
1999	Umweltbundesamt, Vienna, Austria	Gundula Prokop, Dr Luca Montanarella

European Soil Bureau

The activities of the ESB are, and have always been, driven essentially by the demands for soil information by the EU Member States and the European Commission.

The needs of these two large user communities are gathered through two committees, the Advisory Committee of the ESB and the Inter-DG Coordination Group on Soil Information.

Official delegates from the 15 EU Member States, and from the EFTA countries, form the ESB Advisory Committee. Observers from the major International organisations (FAO, UNEP, etc.) and from the EU neighbouring countries are also admitted but they have no voting rights. The Advisory Committee insures the necessary link between the activities of the ESB and the relevant policies and activities concerning soil in the individual EU Member States and in the Commission.

The Inter-DG Coordination Group on Soil Information is an inter-service working group with participants from all the relevant services of the European Commission involved directly or indirectly with soil related issues.

The services most heavily involved in soil related policies are DG VI (Agriculture) and DG XI (Environment), though recently a surge of interest in soil information has been observed coming from other Commission services.

These are most notably DG XVI (Regional policy) in relation to the European Spatial Planning Perspective (ESDP), and DG I and DG VIII in relation to soil information in non-EU countries.

The extension of the European soil databases to non-EU countries has indeed been stimulated by the needs of these Directorates General. Recently, the United Nations Convention to Combat Desertification has become active, and the European Union, as one of the signatories to the Convention, will have to strengthen its capability to provide adequate soil information systems in the affected regions. Therefore extension of the current coverage of the soil databases, available from the ESB, is foreseen after 1999.

The needs identified by the guiding bodies, the Advisory Committee of the ESB and the Inter-DG Co-ordination Group on Soil Information, are collected by the Secretariat of the ESB and transmitted to the Scientific Committee.

The Scientific Committee is in charge of implementing the necessary activities in response to these needs for soil information.

ESB Working Groups

The ESB Scientific Committee comprises relevant European experts in soil science and operates through small ad hoc working groups, in charge of performing the single tasks requested by the soil information users. Currently (1999) there are five working groups active within the ESB and these are described in the sections that follow.

The 1:1,000,000 European soil database working group

This working group has already been operating since 1991. It has been the driving force of a joint effort of many soil scientists from different countries to improve the quality and geographical coverage of soil data for Europe. Chairman of the group is Dr. M. Jamagne (SESCPF, INRA, Orleans). The current version of the Soil Geographical Database of Europe (Figure 2) covers the EU Member States, the Central and Eastern European countries (Poland, Czech Republic, Slovakia, Hungary, Romania and Bulgaria), the Baltic States (Lithuania, Latvia and Estonia), Norway, Switzerland, former Yugoslavia and Albania (Jamagne *et al.*, 1995).

A version of this database is expected to be ready for general distribution in 1999. It will form the core of a European Soil Database (ver 1.0) that will incorporate the following data sets:

1. Soil Geographical Database of Europe (SGDBE)
2. Soil Profile Analytical Database of Europe (SPADE), described by Madsen and Jones (1995, 1998).
3. Hydraulic Properties of European Soils (HYPRES) database (Wosten *et al.*, 1998), linked to the 1:1,000,000 soil geographical database of Europe.
4. Pedotransfer Rules (PTR) database, derived from an expert system for the estimation of several additional parameters needed for environmental interpretations of the soil map (King *et al.*, 1994; van Ranst *et al.*, 1995).

This database therefore consists of a geographical data set, a semantic data set, a soil profile analytical database, a soil hydraulic parameters database and a knowledge database. It represents a first step in the development of a fully integrated European Soil Information System (EUSIS), the concept of which is described by Le Bas *et al.* (1998).

It is expected that the development of this soil information system will continue into the next Millennium with the extension of the geographical coverage to include the countries of the Former Soviet Union and those of the Mediterranean basin. The main aim is to establish a common framework at continental scale to plan the sustainable use of the soil resources in Europe.

The European Soil Database is recognised by the contributing countries, and by the European Environment Agency (EEA), as a reliable source of soil information. Its participatory approach allows full integration of knowledge that exists at local level into a European framework.

This depends on the strength of the network of soil science institutes around Europe and the good working relationships that have been established because of the long standing contacts made in the past (see Table 1). These are the main reasons for the success of the ESB.

There is a wealth of soil information available in the Eastern European countries that can be fully integrated into a wider European context. One of the major aims in the immediate future is to give the soil scientists of the Former Soviet Union the opportunity to see their work revitalised and valued in a broad European context. These countries, including Russia the birthplace of soil science, can make a very valuable contribution to the overall quality and content of the European Soil Information System.

The existing European Soil Information System (EUSIS) has given Europe a tool comparable in importance to the other well established systems in other parts of the world, for example the National Soil Information System, NASIS (in the United States of America) and the Canadian Soil Information System, CANSIS. Although EUSIS is fully compatible with the FAO World Soils and Terrain database (SOTER), the scale (1:1,000,000) of its current graphical component is much larger than for any of the FAO databases that relate to Europe.

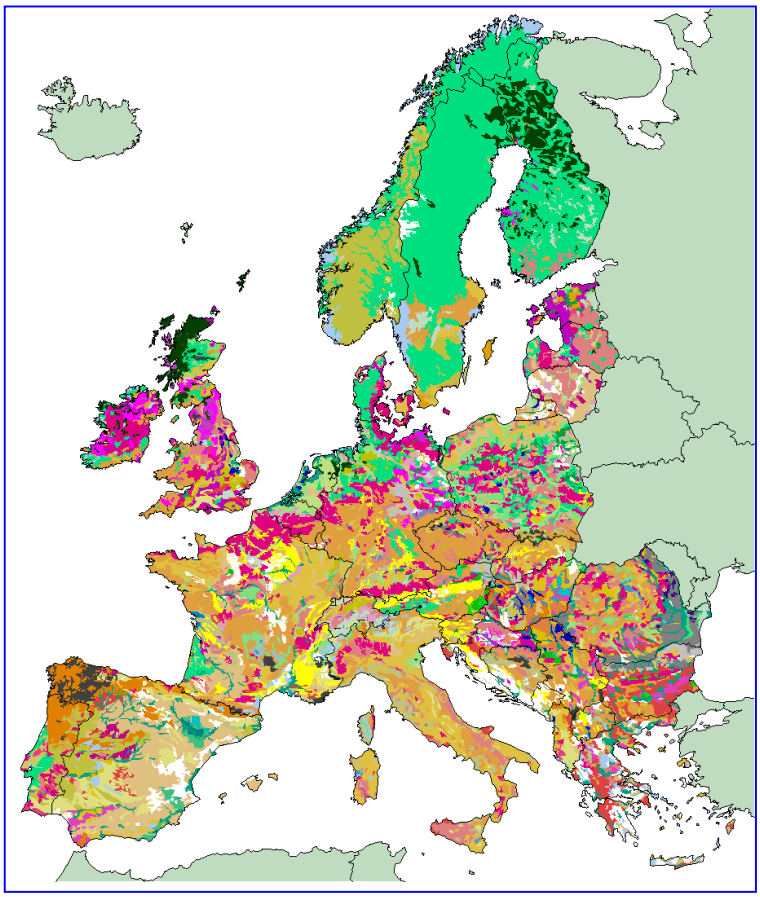


Figure 2: Current extent of the European Soil Database Ver. 1.

Information Access Working Group (IAWG)

This working group has turned out to be one of the most important within the ESB. It is in charge of the development of a European policy for access to soil data and as such is pioneering an approach that will be applicable to other data in future. The general aim of the group has been to develop guidelines that insure the maximum protection of the ownership of the data, together with regulated access for all the potential users.

The combination of these two elements produces a data access policy that is intended to maximise database availability and use (Jones, 1998) but to safeguard the intellectual property rights (IPR) of the Contributors. The Licensor of the soil data is the European Commission, through the European Soil Bureau (ESB) which has become a focus for licensing and distributing the data.

Data are leased for a fixed period (minimum of 1 year), and not sold. Charges are fixed according to a price matrix (Jones *et al.*, 1998).

The adopted price matrix differentiates the cost of leasing the data according to the proposed use. Minimum charges (= cost of handling) are levied on the Contributors and non-profit organisations for internal use. Intermediate charges will be levied if these organisations then wish to use the data for externally sponsored contract work. Maximum charges are applied to full commercial uses by private organisations.

The 1:250,000 working group

This group will be of increasing importance in the future of the ESB. To date it has produced a framework for designing and constructing the new European soil database at scale 1:250,000. The Chairman of the group is Dr. Peter Finke (SC-DLO, Wageningen).

The 1:250,000 Georeferenced Soil database of Europe project began following a feasibility study in 1993, prepared by R. Dudal, A. Bregt and P. Finke, sponsored by the Directorate General XI (Environment). This study recommended that a scale of 1:250,000 for the preparation of geographic data would be appropriate as a basis for future environmental applications within the EU.

The project was commissioned to meet a growing demand for soil information at regional or watershed level to complement the databases already developed by CORINE, e.g. for land cover and biotopes at a scale of 1:100,000.

Whilst undertaking the feasibility study, the researchers had established direct contact with national soil survey and land research centres in the EU-12 Member States. From these contacts, augmented by information published in reports from the Heads of Soil Surveys meetings in Silsoe (Hodgson, 1991) and Orleans (Le Bas and Jamagne, 1996), it became clear that the national coverage of soil mapping in Europe, at scales larger than 1:1,000,000, ranged from 10% to 100%.

Therefore, in all EU-12 countries there are at least some areas with soil data sufficiently detailed for conversion to the 1:250,000 scale. It was proposed that this would be achieved by generalisation, complemented by some additional fieldwork. Special attention would be paid to soil and terrain attributes that are deemed important for environmental protection. However, because of a general scarcity of detailed soil data, the feasibility study concluded that complete coverage of the soils of Europe at 1:250,000 scale could only be accomplished in the long term.

As a first step, pilot studies were proposed in areas where detailed data already exist. The aim of these studies would be to test the methodology, develop a common legend and compile a common database appropriate for producing a soil map at a scale of 1:250,000. The European Environment Agency has endorsed this approach (see Scoping study on establishing a European Topic Centre for Soil, DGGU Service Report no. 47, 1995).

The main work of the group has been the preparation of a Manual of Procedures (ESB, 1998), the delineation of the pilot areas and the overall scientific coordination of the project. From the operational point of view, preliminary versions of the database will be created in selected pilot areas, under the guidance of regional co-ordinators. An area covering the North-Italian quaternary plains has already been selected for the first pilot study. The project leader for this area is Dr. R. Rasio (ERSAL-Lombardia). Additional areas have now been defined, covering Central and Southern Italy, and the Alps.

Eventually, the new soil database will be fully integrated into a nested European Soil Information System (EUSIS), as portrayed in Figure 3.

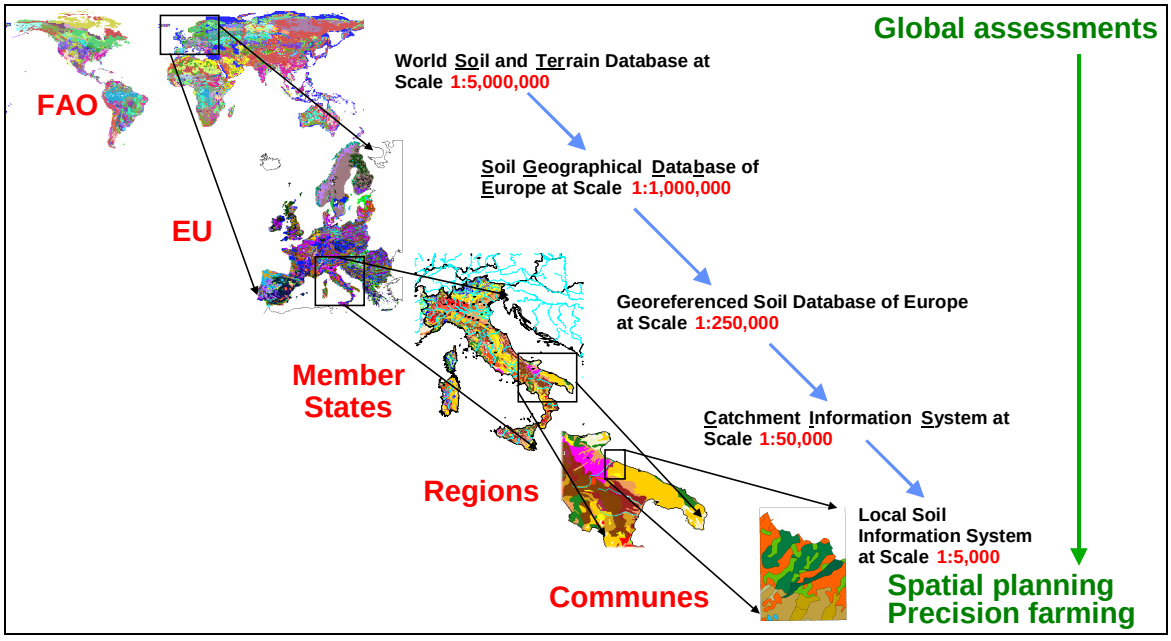


Figure 3: The nested European Soil Information System (EUSIS).

This nested EUSIS will be fully compatible with European soil data in the future and the World Soil and Terrain (SOTER) database of FAO, expected to be ready by 2002. At the same time, EUSIS will link up with the existing National and Regional soil information systems within the EU. It will address the needs of soil information users at different scales, ranging from global (1:5,000,000 scale) down to local (1:5,000 scale) level, that can provide detailed information for spatial planning and precision farming applications.

Spatial soil information will be needed at intermediate scales to respond to the needs of the European Union (1:1,000,000 scale), to the EU Member States (1:250,000 scale) and to Regional and Local authorities (1:50,000 and 1:25,000 scales). The system will also be fully integrated with the soil monitoring activities of the European Environment Agency.

The soil erosion risk assessment working group

This group, chaired by Prof. Dr. N. Yassoglou (NAGREF, Greece), is in charge of the elaboration of a new Pan-European Soil Erosion Risk Assessment (PESERA).

The PESERA project will establish a new georeferenced database of the potential and actual erosion risks in Europe, based on a scale of 1:1,000,000. This scale was chosen because it provides full coverage of the whole of Europe. The methodology is intended to produce an update on the previous CORINE *Soil Erosion Risk and Important Land Resources in Southern Europe* project (CORINE, 1992), which only addresses the situation in southern Europe.

However, full advantage will be made of newly available high quality European GIS data sets, for example the the European Soil Database (at scale 1:1,000,000), a complete CORINE Land Cover database (at 1:100,000 scale), new digital terrain models – DTMs (at resolutions better than 1km x 1km), and additional agrometeorological data.

In addition to the Member States of EU-15, the geographical extension of this new soil erosion risk assessment will include the former EFTA countries, the Central and Eastern European countries (including the Baltic States, former Yugoslavia and Albania). Additionally, two more detailed studies will be performed at scale 1:250,000, covering Italy and Albania respectively. Currently the group has undertaken a preliminary test on data for France (Figure 4), as a first step in establishing the most appropriate pan-European soil erosion risk methodology.

The soil analytical methods working group

This group is chaired by Prof. Dr. E. Van Ranst (Univ. of Gent, Belgium) and is in charge of harmonising soil analytical methods for the development of the European Soil information System (EUSIS). The group is closely linked to the new activities of the Soil and Waste unit of the Environment Institute (EI), JRC. It has produced an inventory of interpretative computer models

that use soil data to provide information for decision-makers. The inventory also identifies future needs for soil data as input to these models. This is a key issue, as there is often a mismatch between the data available within existing soil information systems and data needed by the relevant models for the production of derived products.

Soil Information Needs in Europe

During the last two years there has been a surge of requests to the European Soil Bureau for data on European soils. This increase in activity has arisen for a number of reasons.

- ◊ Establishment of the European Environment Agency, and of its European Topic Centre on Soils, has generated a need for a large amount of soil related information.
- ◊ Growing concern about the impacts of agriculture and other human activities on soils has triggered a number of policies and regulations that need soil information for their implementation.
- ◊ Specific EU policies, like the Common Agricultural Policy, the 5th Environmental Action Plan, the European Spatial Development Perspective and others, require harmonised soil information within the European Union.
- ◊ Internationally binding agreements, like the UN Convention to Combat Desertification (UNCCD), call for detailed soil information at a regional scale (specifically annex 4 of UNCCD requests comparable soil information for the countries of the Mediterranean basin).
- ◊ Environmental disasters, such as landsliding, flooding, etc., in some EU Member States, have highlighted the need for adequate soil information for disaster prevention.

These increasing demands go far beyond the existing capabilities of the European Soil Bureau and a much larger and better resourced organisation is required if they are to be satisfied. This was one of the main conclusions of the recent meeting in Germany on 'Soil Protection Policies within the European Union' (Bonn, 9-11 December 1998). The so-called 'Bonn Memorandum' issued after this meeting, calls for a European Soil Forum among high-level officials and decision-makers to establish a 'common ground' for soil protection policies in Europe.

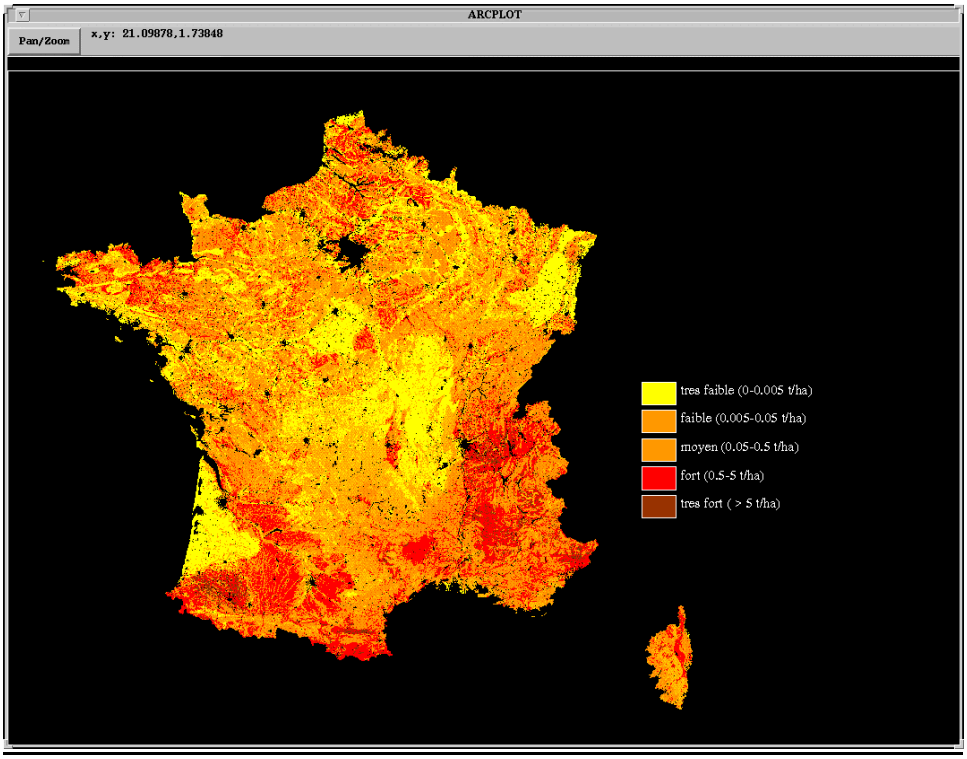
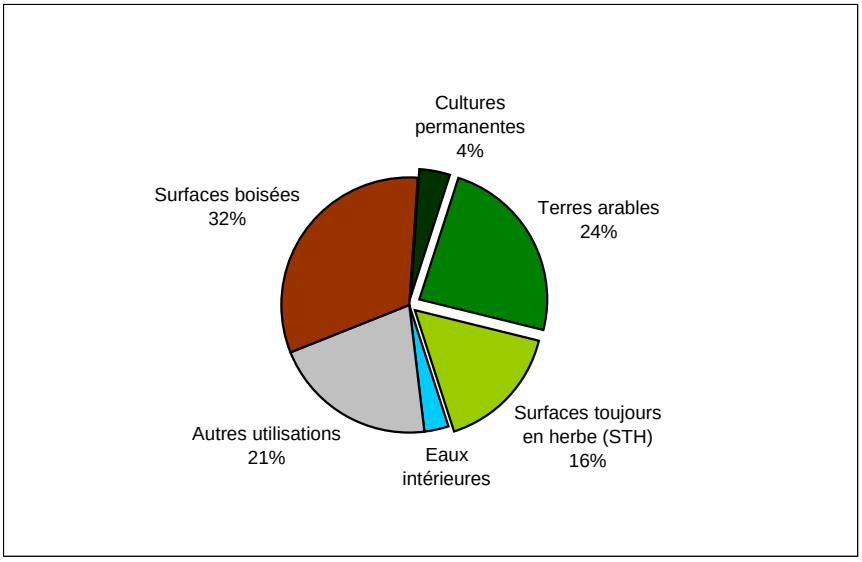


Figure 4: Soil erosion risk in France using a new Pan-European approach



Source: Eurostat/ZPA1

Figure 5: Major land uses within EU–15 (1997).

There is indeed a growing need for such a forum, as society becomes more and more aware of the many functions soils are performing for human well being. It is the multifunctionality and apparent longevity of soil that has always hindered the adoption of appropriate conservation and protection measures. Traditionally, agriculture has been the major stakeholder and driving force behind soil conservation.

However, there are now many other stakeholders having a direct interest in this complex environmental property. In the new context of a reformed Common Agricultural Policy (CAP), as delineated in the Agenda 2000 of the European Union, the need to create some 'common ground' that will allow the new stakeholders, that are starting to profile themselves in Europe, to combine their efforts is reinforced.

These stakeholders include environmentalists, rural community specialists, spatial and urban planners, and experts on tourism and recreation, as well as the regional and national governments. They all have an interest in soil because of its multifunctionality: supporting industry, construction, and cultural heritage; acting as a filter for terrestrial water, a reservoir of biodiversity, and a source of building ground.

The needs of these new stakeholders must be balanced with those of the 'traditional' users of the soil – the farmers – who produce our food. This becomes very clear if we consider the current (1997) land use within the EU (Figure 5).

In this new context, the European Soil Bureau must expand its resources so that it can respond to the needs for soil information from these new users.

The issues related to soil protection and to the development of suitable indicators for the assessment of soil degradation will become a priority in the next few years. The current databases (King *et al.*, 1998) were designed primarily to help scientists respond to issues of soil fertility in a 'climate' that, until recent times, was striving to make European agriculture more productive.

Today needs have changed with emphasis now focussed on the relationship between soil and the quality of agricultural products, and the impact of agriculture and other human activities on soil quality itself.

New and more detailed soil information for the whole of Europe is required to address the following specific problems:

1. Pollutant transfer (and subsequent impacts on water quality):
   i) Agrochemicals: nitrate and pesticide leaching, and phosphorus contamination;
   ii) Heavy metal contamination;
   iii) Immobilisation of radionuclides.

2. Waste disposal:
   i) Agricultural wastes: animal manures and effluents;

ii) Domestic and industrial wastes: sewage sludge.

3. Soil degradation:
   i) Soil structural degradation, caused by organic matter loss, salinisation and increased subsoil compaction;
   ii) Erosion (risk) by water and wind, causing loss of fertility, and physical and chemical pollution.

4. Land suitability and management:
   i) New and alternative crops;
   ii) Traditional arable crops: sustainable production, precision farming;
   iii) Yield forecasting: crop models;
   iv) Water requirements at Catchment level.

5. Geotechnical aspects:
   i) Soil stability/subsidence;
   ii) Corrosivity

Such information is now needed urgently to support the policy makers who have the responsibility of formulating and implementing new directives. There is now ministerial agreement that every EU member state must put environmental protection measures into place at regional level and that these measures should include a code of Good Agricultural Practice.

The links existing between the quality of agricultural products and soil properties have been well studied, but we are still missing assessments at small scale for EU policy needs. Few data are available on the degree and extent of soil degradation caused by unsustainable agricultural practices. The same is true for other forms of soil degradation caused by industrial and other non-agricultural activities, such as sealing, contamination, etc.

A new effort is needed for the collection of updated and relevant information on European soils in order to implement more effective soil protection policies at EU level.

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