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# Integrated soil and water management for orchard development

## Role and importance

UNIVERSITÀ DEGLI STUDI DI TERAMO

FIAT PANIS

Integrated soil and water management for orchard development — Role and importance

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Proceedings of the International Seminar
"The role and importance of integrated soil and water management for orchard development"

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# Contents

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# Foreword

A two-day international seminar on the role and importance of integrated soil and water management for orchard development (vineyards and olive trees) was held at the College of Agricultural Sciences, the University of Teramo, Mosciano S. Angelo, Italy, on 9–10 May 2004.

The principal seminar themes were an international-level investigation, exposition and statement of the "current state of art" and emerging issues concerning integrated soil and water management for viticulture and olive-tree crops. The seminar facilitated the diffusion of results from a wide range of research in different parts of the world on soil and water management in vineyards and olive orchards.

Grapes, olives, figs, almonds, dates and carobs have been cultivated since ancient times in many northern Mediterranean areas, ranging from Portugal and Spain through southern France to Italy, Greece and Turkey, and from the Near East to Egypt, Tunisia and Morocco. More-recent developments have occurred in Australia, the United States of America and various South American countries. In all of these areas, vine and olive production are of major importance; supporting large sectors of the population, occupying significant tracts of land (and commonly the more fragile and marginal land), and ensuring continuing employment and export opportunities through many levels of value-adding in a wide array of related industries. An important challenge facing vine and olive producers is to make more efficient and sustainable use of land, water and plant nutrient inputs in order to meet the present and future demands of these important tree crops. An integration of the best traditional practices with new production techniques geared towards more integrated land and water management could support efforts towards the sustainable intensification of vineyard and olive orchard production without incurring land, water, biological and off-site (environmental) degradation.

At a more farmer-immediate level, vine and olive growers worldwide have recognized for centuries that grapes and olives harvested from different areas of the orchards can produce wines with unique flavours and olive oil with special characteristics. Even under constant variety and rootstock, the feel, bouquet, colour, body and overall wine and oil quality are influenced by different physical factors within the orchard: microclimate, slope, aspect, soil type and waterholding capacity. An important task for scientists and academics is to rationalize and explain these differences with a view to achieving uniform responses across whole fields or vineyards in order to maximize opportunities of achieving desired outcomes in terms of taste, colour and body as well as productivity.

The workshop attracted a wide variety of presenters, including 11 invited keynote speakers from Australia, Chile, France, Italy, Portugal, Spain, Syrian Arab Republic, the United Kingdom, and the United States of America, and 14 poster presentations. The field excursion visited a range of local vine- and olive-producing areas and had hands-on demonstrations of soil visual assessment, recently developed techniques for soil-moisture assessment, and state-of-the-art displays of commercial equipment for the interrow management of orchards. The workshop concluded with a round-table discussion involving all delegates that investigated the four themes: the role and importance of cover crops; machinery use; soil and water measurement/monitoring; and types and role of simulation models. Each theme was considered in terms of "moving towards future initiatives in research, teaching, technology and development."

Several "follow-up" scenarios were considered for maintaining the group dynamics and continuing the interchange of ideas initiated at the seminar. Suggestions included:

conduct a further meeting on similar themes in two years' time to seek updates on current experiments and initiatives; produce a twice-yearly newsletter to keep the group active and publish current initiatives; and establish a World Wide Web area to place details of the group's activities for discussion and dissemination.

# Executive summary

More than 100 participants representing 9 countries (Australia, Chile, France, Italy, Portugal, Spain, Syrian Arab Republic, the United Kingdom, and the United States of America) attended a two-day seminar at the College of Agricultural Sciences, the University of Teramo, Mosciano S. Angelo, Italy, on 9–10 May 2004. The principal objective was to facilitate the diffusion of results from the wide range of research in different parts of the world on soil and water management in vineyards and olive orchards. A one-day field excursion was followed by a day of oral and poster presentations, concluding with a round-table discussion involving all participants. The field excursion visited vine and olive groves in the countryside around the University of Teramo. Four field-based exhibitions were conducted at the university's field site on the farm of Flaviano Di Giovanpietro, 8 km north of the university campus, located in the rolling green hills between the Gran Sasso peak and the Adriatic coast. Exhibits included:

- a field demonstration of visual soil assessment for vine and olive groves, including soil descriptions of the experimental treatments, and field measures of pH, slaking/dispersion and water infiltration (hydraulic conductivity);
- soil capacitance probes for real-time soil-water monitoring by Sentek Pty. (Australia);
- new technology for cover crop/grass cutting in vineyards by Tanesini Technology;
- a field demonstration of new irrigation systems by Irritec & Siplast.

Day two consisted of 14 oral presentations, 14 poster presentations, and a concluding round-table session to hear the opinions of the delegates and to achieve a consensus. The oral presentations covered a wide range of subjects related to the themes and objectives of the seminar, in particular:

- The local and global importance of the workshop was emphasized, particularly as local grape and olive producers compete at the world-market level. The workshop was deemed important, not only to local growers but also municipal officials and administrators as they are ultimately accountable for local economic viability and environmental quality.
- The presence and input of the international scientists at the workshop was applauded as were their efforts to bring widely tested techniques and systems to the local community, and to cross-check data and local system viability.
- The input of the European Commission focused on recent reviews of Common Agricultural Policy and the Thematic Strategy for Soil Protection of the European Union. In particular, it highlighted a developing theme: "protection of the soil" and its link with good agricultural practices. Land protection is linked strongly with heritage protection; protecting the aesthetic nature of these lands that is such a draw for tourists. The current dependency on widely spaced grid surveys with subsequent intergrid node modelling for mapping is being supplemented and validated with the increased collection of soil, land and vegetation measures. The multifunctional nature of the use of land and the causes of land deterioration was also recognized.
- Another focus concerned Italy. With 1.2 million ha of olive groves, Italy is the second largest producer of olives in the world. Eight percent of this production is in southern Italy, with 40 000 ha in the Abruzzo region (where the seminar was held). The predominance of olive groves on marginal and sloping land underscores the need for continuing sustainability vigilance.

Only 3 percent of the world's agricultural land is classed as "suitable" for cropping, hence the strong requirement to enact the four principles of conservation agriculture (soil cover, zero tillage, restriction of in-field traffic, and routine soil inspections) with an emphasis on "farmer–farmer" technology transfer. The importance was stressed of soil biopores formation from cover crops and earthworms activity for enhancing water infiltration in vineyards and olive groves. This represents a more dependable and longer-term solution than tillage with its inherent, high risk of erosion on sloping lands.

- A simple field method was reported for the routine soil inspection of soil quality and health, based on visual descriptions and simple, scientifically robust field measures. Designed to be farmer-usable, the system provides a testing and monitoring system to support positive change in on-farm practices.
- Olive production in Portugal now emphasizes permanent soil cover for erosion control with associated increased soil organic matter and biota (earthworms) and decreased crusting and runoff. Farmer leadership and field days are important for enacting new on-farm technology such as telescopic arms on pickers, concentrated herbicide use, near-tree placement, and shielded sprayers. Negative environmental impacts are lessened by improved farming practices. Demonstrations of improved olive quality and yield are vital as increased profit is important to achieving farmer adoption.
- Vine production in Spain has traditionally used soil ripping to 50 cm for weed control and infiltration. Recent increased numbers of drought years with rare but aggressive rainfall events has emphasized the need for zero tillage and cover crops in order to minimize soil erosion in vineyards.
- Irrigation scheduling in olive groves and vineyards, employing real-time capacitance probe measurements and awareness of land variability, is a vital way of ensuring continuing productivity in a long-term, sustainable system.
- Chilean wine production with drip irrigation has achieved a 20–30 percent increase in wine quality combined with a 20–60 percent reduction in irrigation water applied.
- Olive production in Spain is largely rainfed on sloping land with low-quality soils. The traditional use of tillage for weed control and soil aeration is lessening; being replaced by cereal cover crops in interrows with herbicide or mowing control of vegetation below trees. Results demonstrate improved water infiltration in the interrows beneath cover crops.

Fifty delegates participated in the concluding round-table discussion. This was structured to cover the four major discussion topics of the earlier sessions: the role and importance of cover crops; machinery use; soil and water measurement/monitoring; and types and role of simulation models. Each of four working groups deliberated the theme "moving towards future initiatives in research, teaching, technology and development" before regrouping for a plenary discussion on "putting it all together – the development of linkages between land, water, crop quality, institution building, marketing, policies and modelling". The closing statement emphasized the need to use the outputs of the two days to "go forward" and face the continuing challenge of achieving practical, sustainable use of land in vineyards and olive groves, worldwide.

# List of acronyms and abbreviations

| | |
|---|---|
| $\Psi_b$ | Predawn leaf water potential |
| AI | Selyaninov Aridity Index |
| ANOVA | Analysis of variance |
| AWHC | Available waterholding capacity |
| AWS | Automatic weather station |
| BD | Bulk density |
| $CaCO_3$ | Calcium carbonate |
| CAP | Common Agricultural Policy |
| CCE | Calcium carbonate equivalent |
| CFU | Colonies forming unit |
| CITRA | Research and Extension Centre for Irrigation and Agroclimatology |
| $CO_2$ | Carbon dioxide |
| COI | Olive Oil Council |
| CORINE | Coordinated Information on the European Environment |
| $C_s$ | Stomatal conductance |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation, Australia |
| Cu | Copper |
| CV | Coefficients of variation |
| DD | Degree day |
| DEM | Digital elevation model |
| DMRT | Duncan's Multiple Range Test |
| DOP | Protected Denomination of Origin |
| DSS | Decision-support system |
| DTM | Digital terrain modelling |
| DU | Water distribution |
| ERD | Effective rooting depth |
| ET | Evapotranspiration |
| ETo | Reference evapotranspiration |
| $ET_{vine}$ | Vine evapotranspiration |
| EU | European Union |
| FC | Field capacity |
| GIS | Geographical information system |
| GLASOD | Global Assessment of Human Induced Soil Degradation |
| GMD | Geometric mean diameter |
| GPS | Global positioning system |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| IGP | Protected Geographical Indication |
| IMDS | Irrigation-management decision system |
| INRA | Institut National de Recherche Agronomique, France |
| IRO–CNR | Institute of Research on Olive Production of Perugia |
| ISAFoMCNR | Institute for Agricultural and Forest Mediterranean Systems, National Research Council, Italy |
| IT | Irrigation timing |
| *K* | Hydraulic conductivity |
| Kc | Crop coefficient value |
| Kr | Irrigation coefficient |

| | |
|---|---|
| Ks | Stress coefficient |
| LADA | Land Degradation Assessment in Drylands, FAO project |
| LAI | Leaf area index |
| MAD | Maximum allowed depletion |
| MARS | Monitoring Agriculture with Remote Sensing |
| MVP | Moister virgin pomace |
| NV | Nutrivant |
| NVS | Natural vegetation strip |
| O.Mi.By.P. | Olive-mill by-products processor |
| OC | Organic carbon |
| OMW | Olive-mill waste |
| OMWBS | Olive-mill waste-based substrata |
| OMWW | Olive-mill wastewater |
| PESERA | Pan-European Soil Erosion Risk Assessment |
| PON | Prebloom Olive Nutrivant |
| PRD | Partial rootzone drying |
| RDI | Regulated deficit irrigation |
| SALUS | System Approach to Land Use Sustainability |
| SARDI | South Australian Research and Development Institute |
| SMU | Soil map unit |
| SOM | Soil organic matter |
| SON | Summer Olive Nutrivant |
| SVA | Soil visual assessment |
| $TEMP_{cor}$ | Temperature correction |
| TIRSAV | Tecnologie Innovative per il Riciclaggio delle Sanse e delle Acque di Vegetazione |
| TVI | Temperature Variability Index |
| USLE | Universal Soil Loss Equation |
| VP | Virgin pomace |
| VQPRD | Quality Wine Produced in a Well-defined Region |
| WP | Wilting point |
| WW | Wool waste |

# Papers presented at the seminar

# Emerging issues in soil and water management for vineyard and olive-tree orchards


## ABSTRACT

The recent mid-term review of the Common Agricultural Policy and the communication by the European Commission "Towards an EU thematic strategy for soil protection" have raised new environmental concerns in relation to intensive vine and olive production in Europe. The main issues are soil erosion, loss of organic matter, and diffuse contamination. A first step towards reversing these negative trends is the establishment of coherent and policy-relevant information covering the whole cycle of driving forces, pressures, states, impacts and responses.


## INTRODUCTION

The recent mid-term review of the Common Agricultural Policy (CAP) has further strengthened the focus on environmental concerns by the agriculture sector. With particular reference to soil and water management, Council Regulation (EC) no. 1782/2003 of 29 September 2003 has identified (Article 5) the need for member states to ensure that all agricultural land is maintained in good agricultural and environmental condition. Annex IV to this regulation further specifies issues that need to be taken into account when evaluating the correct implementation of Article 5. These issues include soil erosion, organic matter levels, and soil structure. These soil-related criteria can be derived directly from the list of major threats to soils in the European Union (EU) as mentioned in the Communication by the Commission to the Council and Parliament COM (2002) 179 "Towards an EU thematic strategy for soil protection". In this communication, the Commission has outlined the major steps that will lead to a coherent approach within the EU for soil protection. It identifies the major distinctive feature of soils, as distinct from air and water, that make the development of legislation for soil protection quite different from the other environmental compartments.

The Communication clearly identifies soil protection as a cross-cutting issue that needs to be addressed in many different policy areas that affect soil quality. The major area of implementation is, of course, agriculture as it is still the predominant land use in the enlarged EU. Therefore, the CAP becomes one of the more effective instruments for achieving successful soil protection, particularly against major threats such erosion, decline in organic matter, and soil compaction.

## SOIL PROTECTION IN VINEYARDS AND OLIVE-TREE ORCHARDS

Much attention has been devoted to extensive soil-degradation phenomena occurring in the Mediterranean basin area, particularly in areas under permanent crops, such


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as vines and olives. Recent reports have highlighted the negative impacts of intensive olive-tree and vineyard cultivation in the area. Soil degradation is usually a major concern, with figures reporting erosion estimates for olive orchards in Andalusia of 80 tonnes/ha/year as a general value for olive orchards; 60–100 tonnes/ha/year in conventionally tilled olive orchards with trees aged 55–100 years and average slopes of 10–33 percent in Cordoba.

Linked with erosion, there is the major concern of a steady decline in levels of soil organic matter (SOM) in the Mediterranean area, with values often below 2 percent in agricultural soils (Zdruli, Jones and Montanarella, 2004).

The third major threat to soils in Europe as identified in COM (2002) 179 is soil contamination. Concerns have been raised about diffuse soil contamination in vineyards and olive orchards by agrochemicals, particularly by copper compounds in some areas.

## SOIL EROSION

Soil erosion by water is a widespread problem throughout Europe. A report for the Council of Europe, using revised Global Assessment of Human Induced Soil Degradation (GLASOD) data (Oldeman, Hakkeling and Sombroek, 1991; Van Lynden, 1995), estimates that 12 million ha of land, in Europe (including part of the former Soviet Union), or about 10 percent of the area considered, is strongly or extremely degraded by water erosion.

The dominant effect is the loss of topsoil, which is often not obvious but nevertheless potentially very damaging. Physical factors, such as climate, topography and soil characteristics, are important in the process of soil erosion. In part, this explains the difference between the severe water erosion problem in Iceland, and the much less severe erosion in Scandinavia where the climate is less harsh and the soils are less erodible.

The Mediterranean region is particularly prone to erosion. This is because it is subject to long dry periods followed by heavy bursts of erosive rain, falling on steep slopes with fragile soils, resulting in considerable amounts of erosion.

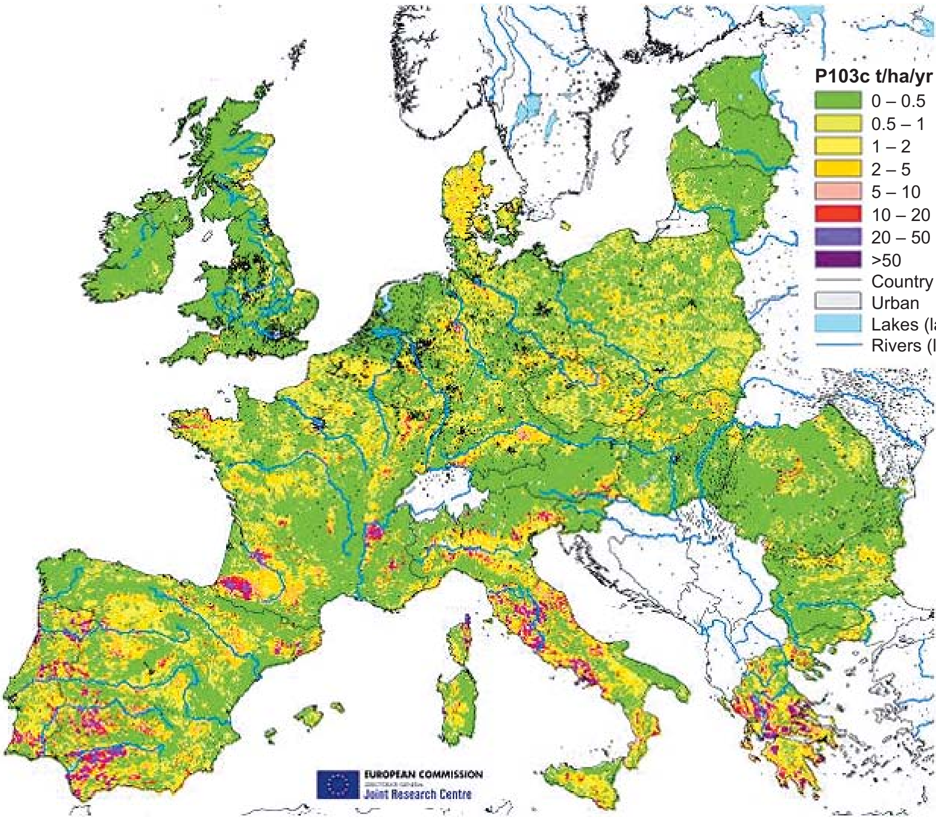
This contrasts with northwest Europe, where soil erosion is slight because rain falling on mainly gentle slopes is distributed evenly throughout the year. Consequently, the area affected by erosion in northern Europe is much more restricted in its extent than in southern Europe.

In parts of the Mediterranean region, erosion has reached a stage of irreversibility. In some places, it has practically ceased, because there is no more soil left. With a very slow rate of soil formation, any soil loss of more than 1 tonne/ha/year can be considered irreversible within a time span of 50–100 years. Losses of 20–40 tonnes/ha in individual storms, that may happen once every two or three years, are measured regularly in Europe, with losses of more than 100 tonnes/ha in extreme events (Morgan, 1995).

It may take some time before the effects of such erosion become noticeable, especially in areas with the deepest and most fertile soils or on heavily fertilized land. However, this is all the more dangerous because, once the effects have become obvious, it is usually too late to enact prevention or repair strategies.

**Plate 1**
*Intensive olive production near Seville, Spain (trees 5–80 years old)*

FIGURE 1
**PESERA: annual soil-erosion risk in Europe**



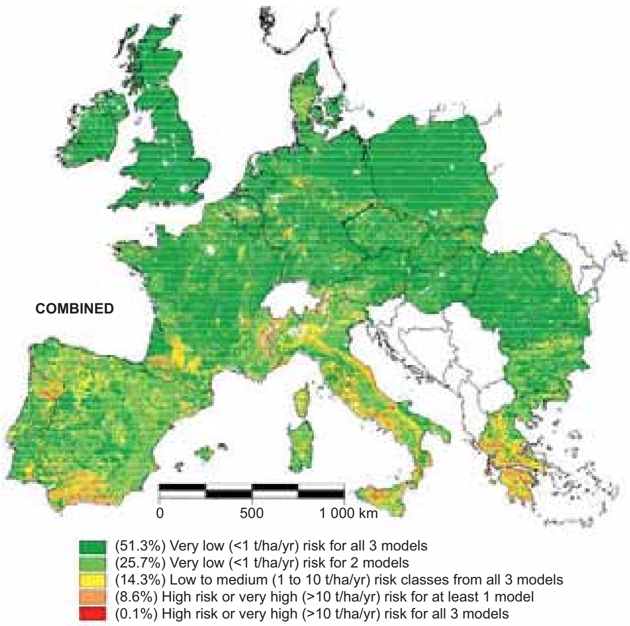

The main causes of soil erosion are still inappropriate agricultural practices (e.g. Figure 1 shows the effect of intensive olive cultivation in Andalusia), deforestation (including forest fires), overgrazing and construction activities (roads, railways, etc.) (Yassoglou *et al*., 1998).

The difficulty of properly quantifying soil erosion continues to be a major concern. Adequate monitoring data would facilitate indications of current trends and the effectiveness of mitigation measures. The Pan-European Soil Erosion Risk Assessment, known as PESERA (Gobin *et al*., 1999), uses a process-based and spatially distributed model to quantify soil erosion by water and assess its risk across Europe. The conceptual basis of the PESERA model can also be extended to include estimates of tillage and wind erosion. Preliminary results for PESERA (Figure 1) are currently being validated using erosion measurements from several European countries (Van Rompaey *et al*., 2003).

Thus, being a quantitative model, PESERA has the potential for dealing with pan-European applications more readily than an expert-based approach. It provides a basis for replacing estimates from Coordinated Information on the European Environment (CORINE) without making excessive data demands. However, further development of the PESERA model and a substantial amount of calibration and validation work are essential in order for it to become operational. Preliminary results suggest that, although the model can be applied at regional, national and European levels, low resolution and poor-quality input data cause errors and uncertainties at local level.

Soil-erosion indicators developed from a physically based model will not only provide information on the state of soil erosion at any given time, but also assist in understanding the links between the different factors that cause erosion. Another

FIGURE 2
**Soil erosion (by rill and interrill) estimated for Europe, based on a combination of three models: PESERA, USLE and INRA**




advantage for policy-making is that scenario analysis for different land uses and climate change is possible using PESERA. This will enable the impacts of agriculture policy, and land-use and climate changes to be assessed and monitored across Europe.

At the European scale, there is an initial need to develop an effective tool for erosion-risk assessment, and to offer it as a component of decision-support systems that can explore the implications of policy options. The PESERA model itself incorporates as many of the physical parameters as can be quantified, but it is important for policy-making to assess the impact of the physical soil loss.

Of the models reviewed, PESERA is the most conceptually appropriate because it takes into account:

- runoff and erosion sediments separately, which are the two components of the global erosion process;
- daily frequency distribution of rainfall month by month, which includes both regular and exceptional events;
- dynamics of soil crusting and vegetation cover, month by month (Le Bissonnais *et al.*, 2003);
- other climate information, such as freezing days that in part cater for the effect of snow and ice.

The other models, such as the Universal Soil Loss Equation (USLE) or that of the Institut National de Recherche Agronomique (INRA), do not take these aspects into account. However, a comparison of the results obtained from three models (PESERA, USLE and INRA) identifies, with greater confidence, areas currently and not currently eroding. Figure 2 presents such a comparison on the data currently available at European level.

In conclusion, no model can give good estimates of erosion where the input data are poor. At the European level, the aim should only be to provide a tool for decision-making at European level. No modelling approach at this level can produce results relevant at the local level.

The following data are needed at European level for models such as PESERA to give satisfactory results:

- soil parameter data derived from scale surveys at 1 : 250 000;
- digital elevation model (DEM) at a minimum resolution of 250 m;
- climate data (e.g. precipitation) at a resolution of 10 km × 10 km;
- up-to-date land/crop-cover data at a resolution of 250 m.

Finally, it must be accepted that any model selected for application throughout Europe will not give satisfactory results in areas where the main process taking place is not included in the model. In the case of PESERA, the results will not be appropriate for areas where snowmelt erosion or erosion from land-levelling is the dominant process. This limitation is not so important as such processes are only locally dominant.

## DECLINE IN SOIL ORGANIC MATTER

In response to the concern about low levels of organic matter in Mediterranean soils and to provide some guidance for policy-makers, the European Soil Database was used to make preliminary estimates of the organic carbon contents of topsoils in southern Europe (Figure 3).

However, the original pedotransfer rules of Van Ranst *et al*. (1995) have been found to give poor results in southern Europe, where the criteria used do not relate well to soil organic carbon content. In an attempt to overcome this problem, the soil map units (SMUs) on the southern part of the European Soil Map were assigned to one of two classes of organic carbon (OC) – OC ≤ 2 percent and OC > 2 percent – using an expert knowledge base (Zdruli, Jones and Montanarella, 2004).

The results (Figure 3) show that 74 percent of the land in southern Europe has a surface soil horizon (0–30 cm) that contains less than 2 percent OC (3.4 percent organic matter). This is an important statistic and it is now clear that the decline in organic matter content of many soils in southern Europe, as a result of intensive cultivation, is now recognized as a major process of land degradation. Table 1 highlights the low levels of OC currently afflicting the countries of southern Europe.

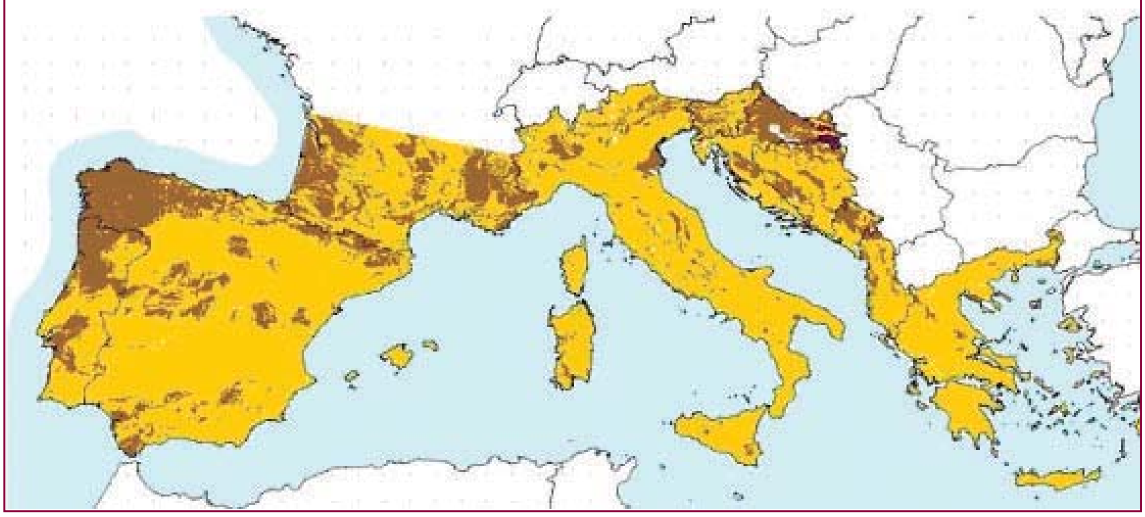
The pedotransfer rules defined by Van Ranst *et al*. (1995) have been refined by Jones *et al*. (2003 and in press). These refined rules have been applied to a 1 km × 1 km soil dataset derived from the European Soil Database, a geographically extended CORINE land cover dataset (Hiederer, 2001; Hiederer and de Roo, 2003), a DEM and accumulated average annual temperature data from the Monitoring Agriculture with Remote Sensing (MARS) project (Vossen and Meyer-Roux, 1995) together with processed data from the Global Historical Climatology Network (GHCN) (Easterling, Peterson and Karl, 1996). The 1-km soil data were produced using a weighting procedure, taking into account soil type variability within the SMUs at European level.

The effect of climate on OC content was accounted for by applying a temperature correction ($TEMP_{cor}$) in the form of a sigmoidal function of the type:

$$TEMP_{cor} = f * \cos(t_{AAAT})^{n} + c$$

where *AAAT* is the average annual accumulated temperature above 0 °C.

FIGURE 3
**Estimated organic carbon contents in topsoils of southern Europe**



Source: Zdruli, Jones and Montanarella, 2004.

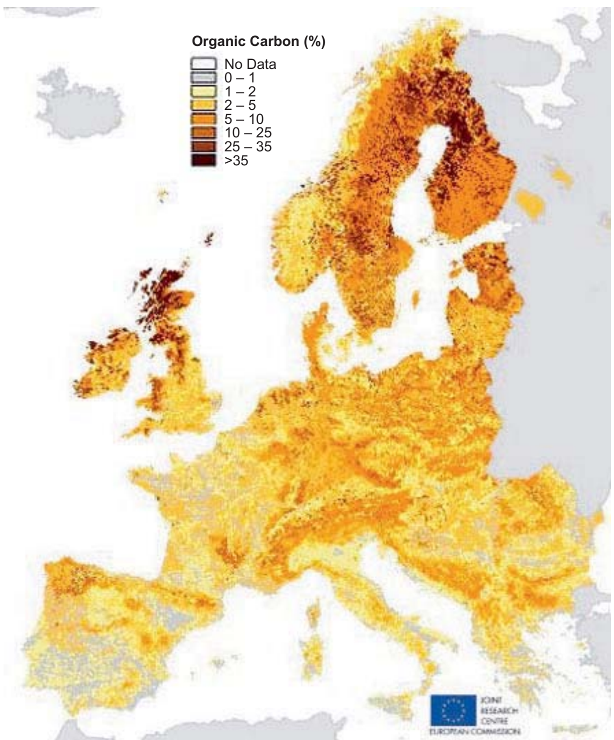
TABLE 1
**Estimated organic carbon (OC) content in the topsoils of southern Europe**

| Country | Total area | Very low to low (OC ≤ 2%) | | Medium to high (OC > 2%) | |
|---|---|---|---|---|---|
| | (km²) | (km²) | (%) | (km²) | (%) |
| Albania | 28 704 567 | 21 575 076 | 75.2 | 6 788 233 | 23.6 |
| Bosnia and Herzegovina | 51 524 030 | 34 453 723 | 66.9 | 16 898 412 | 32.8 |
| Croatia | 56 191 096 | 28 030 731 | 49.9 | 26 903 652 | 47.9 |
| France (S of 45°N) | 196 550 777 | 116 603 968 | 59.3 | 78 371 704 | 39.9 |
| Greece | 133 007 789 | 126 841 043 | 95.4 | 4 868 798 | 3.7 |
| Italy | 300 453 890 | 259 601 949 | 86.4 | 37 341 722 | 12.4 |
| Serbia and Montenegro | 13 792 171 | 7 012 719 | 50.8 | 6 531 899 | 47.4 |
| Portugal | 89 335 536 | 51 026 010 | 57.1 | 37 944 766 | 42.5 |
| Slovenia | 20 235 843 | 11 615 170 | 57.4 | 8 375 443 | 41.4 |
| Spain | 498 914 695 | 378 630 678 | 75.9 | 117 451 853 | 23.5 |
| Southern Europe | 1 388 710 394 | 1 035 391 069 | 74.6 | 341 476 480 | 24.6 |

Final calculated OC values (Figure 4) were compared with measured values from more than 12 000 points in the United Kingdom and Italy (see Figures 5 and 6). The coefficient of determination was found to be 0.9, indicating a good correlation between estimated and calculated OC values.

Because OC content, particularly in the topsoil, changes significantly with land use, any attempt to map the distribution of soil OC in Europe must be based on accurate land-use/land-cover data. Thus, using CORINE land-cover data for the period 1988–1992 is consistent with defining a reasonably accurate OC baseline in 1990.

FIGURE 4
**Organic carbon content of topsoil (0–30 cm) in Europe**



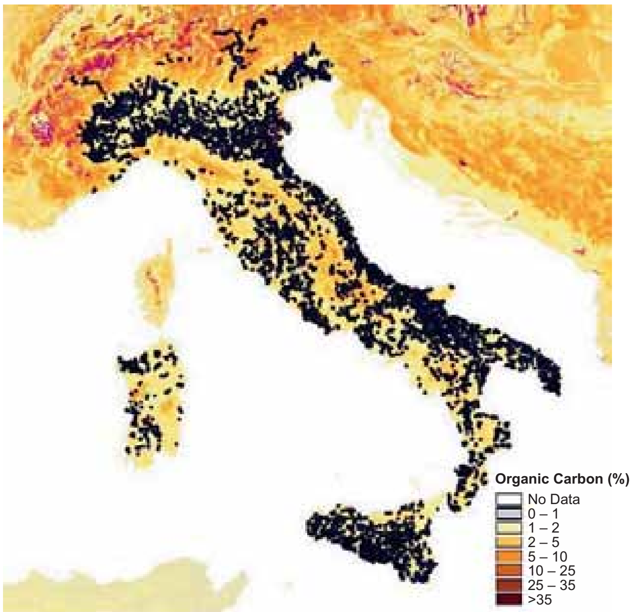

Source: After Jones *et al.*, 2003 and in press.

Serious errors are introduced by assigning measured OC data from a small number of points, deemed to be representative of a particular soil type to polygons delineated on a soil map, that represent much larger areas where no measurements of OC have been made. This is important in view of the fact that OC contents can vary significantly within pedological units on a soil map. This has been shown by the work of Batjes (1996, 1997), who found coefficients of variation (CVs) in topsoil OC contents of 50–150 percent for the same pedological soil group. This problem was avoided in the construction of the OC map and associated 1-km dataset for Europe. Incorporating temperature in the analysis takes account of climate, and using data for the period 1980–89, for correcting the resulting OC distribution, further justifies its consideration as a baseline status for OC in 1990.

Therefore, until better data become available at the European level, it is proposed that the OC for topsoils in Europe (Figure 4) be adopted as the preliminary baseline status of organic carbon/matter in soils at 1990. However, these data, at 1-km resolution, must be further validated against national OC data. This type of work is ongoing in Finland and Scotland (United Kingdom), but similar checks should be made in other countries where suitable data for comparison exist.

Figure 7 shows OC stocks in topsoil for Europe calculated using the data from Figure 4.

FIGURE 5
**Location of sampling sites for determining organic carbon in the agricultural soils of Italy**



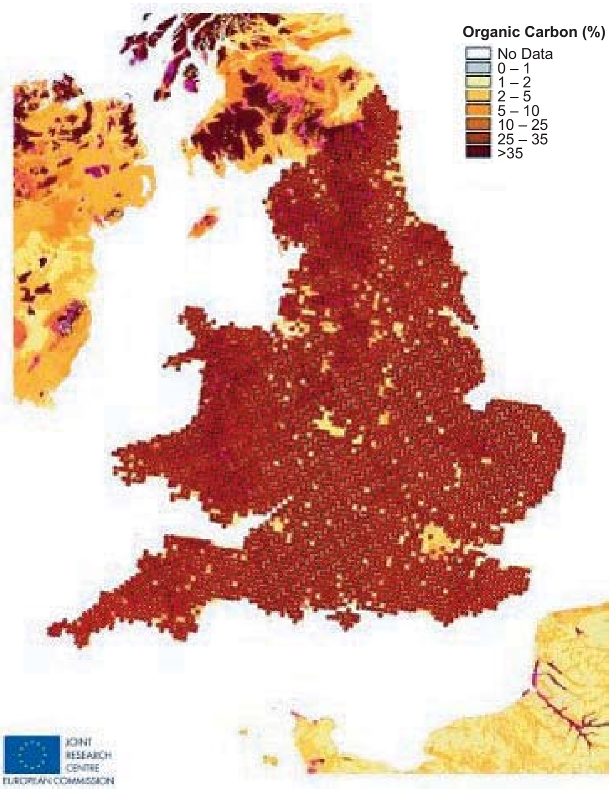

## SOIL CONTAMINATION

Concerns have been raised in relation to the soil contamination of vineyards by copper. The new thematic strategy for soil protection has raised the issue of contamination of soils by heavy metals, caused by a number of practices. This issue is particularly sensitive in view of the revision of the sewage sludge directive and the possible future directive on biowaste disposal. Moreover, knowledge-based policy-making is hampered by the lack of comparable data across Europe on current levels of heavy metals in soils.

A recent inventory aimed to produce a first estimate of the distribution of heavy-metal compounds in EU member states. Figure 8 shows an example for copper.

The data clearly show the large areas with no information, or with information that is difficult to harmonize and compare across country borders.

FIGURE 6
**National Soil Inventory sites (> 5 500) in England and Wales (United Kingdom) overlaid on the map of organic carbon classes for Europe**



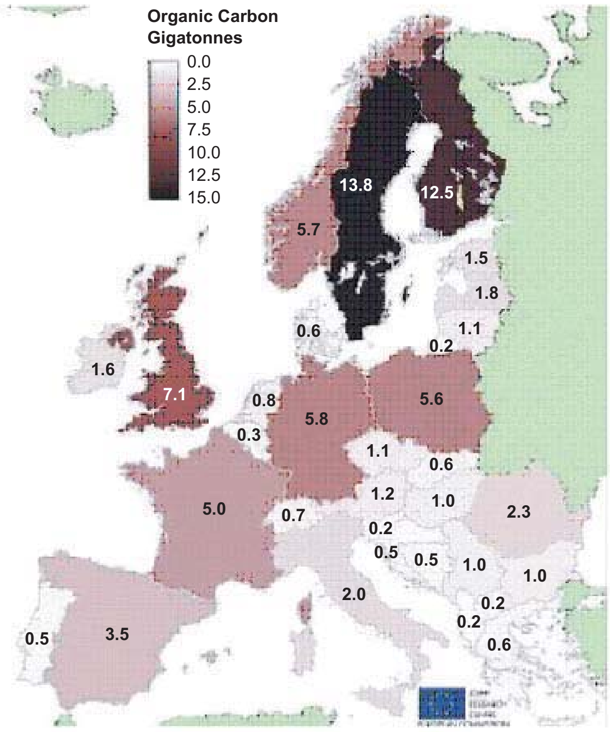

Source: After Jones *et al.*, in press.

## CONCLUSIONS

There are emerging environmental concerns in relation to the cultivation of vineyards and olive orchards. The mid-term review process has tried to address several of these concerns. Special attention is required on the issue of soil degradation, particularly as it intimately linked with water management and good agricultural practices.

There is still a great gap in knowledge across the EU about the extent of these

FIGURE 7
**Organic carbon stocks in topsoils (0–30 cm) in Europe computed from 1-km data**




negative effects. This makes effective policy implementation and cross-compliance difficult.

Therefore, one of the first initiatives proposed in COM (2002) 179 has been the development of an efficient soil information system covering all elements of the cycle of driving forces, pressures, states, impacts and responses and providing policy-relevant information at different scales: at the local level for implementation and advice to farmers; at the regional level for planning and monitoring purposes; and at national and EU level for regular reporting about the status of European soils.

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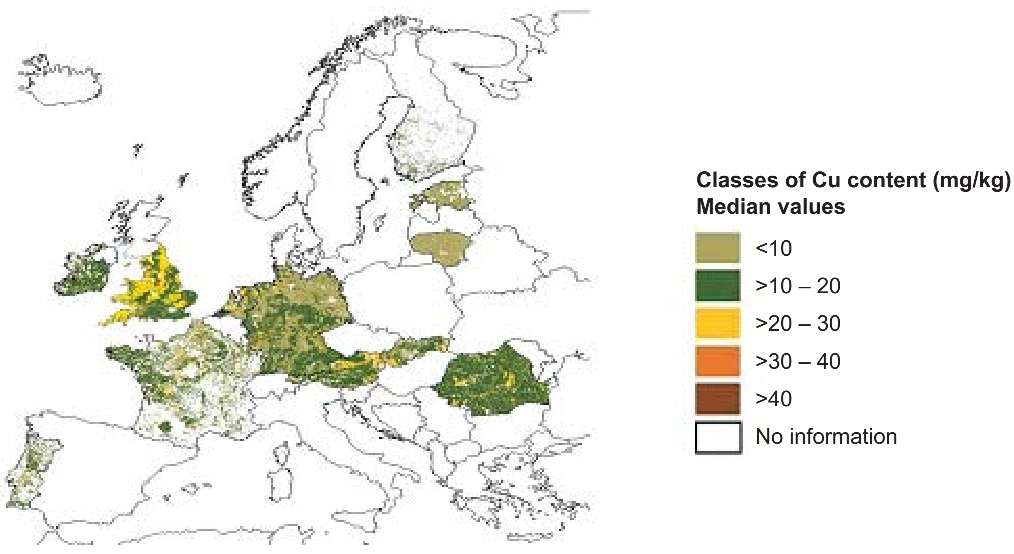
FIGURE 8
**Content of the heavy metal – copper, in European soils in relation to soil parent material and land use**




Source: European Soil Bureau, 1999.

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