

Advances in Soil Survey, Monitoring and Applications in Italy

E.A.C. Costantini

L. Gardin

M. Pagliai

Istituto Sperimentale per lo Studio e la Difesa del Suolo,
Piazza D'Azeglio 30 -50121- Firenze, ITALY

Soil Survey Activity

In Italy, overall soil survey activity has increased considerably in the last few years, but the organisation of knowledge on Italian soils is still in its infancy. This increase in activity of survey has been due to various reasons, but principally to a series of national and European legislations, involving soil investigations as part of measures to protect the environment. Examples of these include regulations relating to the application of nitrogen fertiliser and the spreading of slurries and sewage, and the need for Environmental Impact Analysis prior to infrastructure expansion programmes.

At different administrative levels, i.e., national, regional, provincial and communal, many strategies and regulations involve the need for soil survey. For example, soil data are needed in support of: increased land productivity of vineyards and forests; land planning like 'watershed plans', 'management of water resources plans', 'environmental safeguard plans', 'provincial land co-ordination plans', 'communal regulator plans', 'forest settlement plans' and creation of natural parks.

Another significant impulse to soil survey has been given by the preparation of soil maps for programming the agricultural policy of some Regional Administrations.

In addition to the soil survey activities promoted or introduced by public institutions, there are a number of pedological studies financed by single or groups of private organisations. The most common are land suitability for different crops and, in the last decade, agricultural zoning, particularly in relation to viticulture, or location of sites useful for specific agricultural activities, such as growth of truffles and tree nursery plantations.

Finally, a number of soil surveys are included in research activities led by different Universities, centres of the National Research Council and some Experimental Institutes belonging to the Ministry for Agricultural Policies.

Because of the breadth of activity, it is difficult to give a complete picture of current and recent soil survey. However, the details laid out in this paper give a brief outline of the present situation. Generally, pedological information is relevant, but soil maps and profile descriptions are seldom printed or accessible, and have yet to be introduced into databases.

Institutions and Databases

The main institutional framework for soil mapping and pedological information is the National Observatory for Pedology and Soil Quality of the Ministry for Agricultural Policies, whose tasks are to address and co-ordinate the main public projects dealing with soils in Italy. Few services or pedological initiatives have so far been created by Regional Administrations. A few are in course of establishment, though they have few specialised staff because their role is to manage the surveys and the soil data. Most of the field soil surveyors are now freelance professionals.

A national soil data base is completely lacking in Italy. Nowadays, the only soil maps of the whole country are those at very small scales: 1:5,000,000 (FAO-UNESCO, 1978) and 1:1,000,000 (Mancini, 1966; ESB, 1998).

Only four regions, namely Emilia-Romagna (Regione Emilia-Romagna, 1994), Sardegna (Aru *et al.*, 1990), Sicilia (Fierotti, 1988) and Trentino (Ronchetti, 1965), have a complete soil map at 1:250,000 scale.

Table 1: Area covered by soil maps (including some survey projects ending in 2000)

| | Detailed scale (≤ 1:25,000) | | | Semi-detailed scale (1:30,000 to 1:100,000) | | | Reconnaissance scale (1:150,000 to 1:250,000) | | |
|--------------|--------------------------------|-----|------|--|------|------|--|------|------|
| | ha | % * | % ** | ha | % * | % ** | ha | % * | % ** |
| Italy | 2,868,527 | 9.5 | 40.8 | 9,686,847 | 32.1 | 59.7 | 9,012,400 | 29.9 | 59.1 |

* = mapped area percentage on total area of Italy

** = digitised map area percentage on total soil mapped area

The soil maps of Lombardia and Abruzzo are almost complete, but some other regions are still more or less completely lacking in soil maps and those available are sometimes not homogeneous due to differences in scale, classification systems and survey methodologies. The EU has recently funded a soil survey project called: “Pedological mapping in the Operative Territorial Units” (UOT), in pilot areas of particular agronomic interest within eight regions of Italy: Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia, Sardegna, Sicilia (Napoli *et al.*, 1998). The surveys have led to the production of soil maps at 1:50,000 scale and suitability maps for the most important agricultural uses.

Due to the wide variation in soil maps, the Committee for the National Observatory for Pedology and Soil Quality planned a work programme to establish Monitoring of Soil Maps of Italian regions. This project, called “MONCAPRI”, has been undertaken by the Experimental Institute for Soil Study and Conservation of Florence, which is responsible for collecting and organising soil map information gathered with the courtesy of Regional Administrations. With the collaboration of the Soil Genesis and Ecology Institute of the National Research Council of Florence and the Geography Department of the University of Bologna, an integration of data on soil maps has been possible (Magaldi *et al.*, 1992, Vianello and Zecchi, 1988-90).

Soil maps that have been produced in Italy vary in classification system, mapping methodology and scale because origins, aims and purposes of the various surveys were often different. There are some 433 maps in Italy, of which only 126 (29%) have been digitised (Table 1).

Point observations, profiles and auger holes, amount to about 200,000 in the whole of Italy and soil profiles to about 17,000, of which 84% are georeferenced (Table 2).

Table 2: Soil profiles georeferenced and classified according to different systems

| Classification system | profiles |
|---------------------------|---------------|
| Soil Taxonomy only (USDA) | 6,902 |
| FAO only (Revised Legend) | 96 |
| Soil Taxonomy and FAO | 9,369 |
| Italian Classification | 510 |
| | |
| Total | 16,877 |

The differences in macro-regional distribution of soil maps over time is shown in Figure 1. The general trend shows a geometric increase, mainly due to the activity carried out in Northern and Southern Italy.

In the following figures, more information about actual regional coverage of soil maps at different scales is shown.

Monitoring

A national soil monitoring programme is completely lacking in Italy. The only activity aimed at monitoring the state of soils on a national level is that organised under the European programme “Forest Soil Condition Database”, and carried out in Italy by the Experimental Institute for Plant Nutrition and the Ministry for Agricultural Policies. Under this programme 80 plots have been selected and analysed for a set of chemical properties.

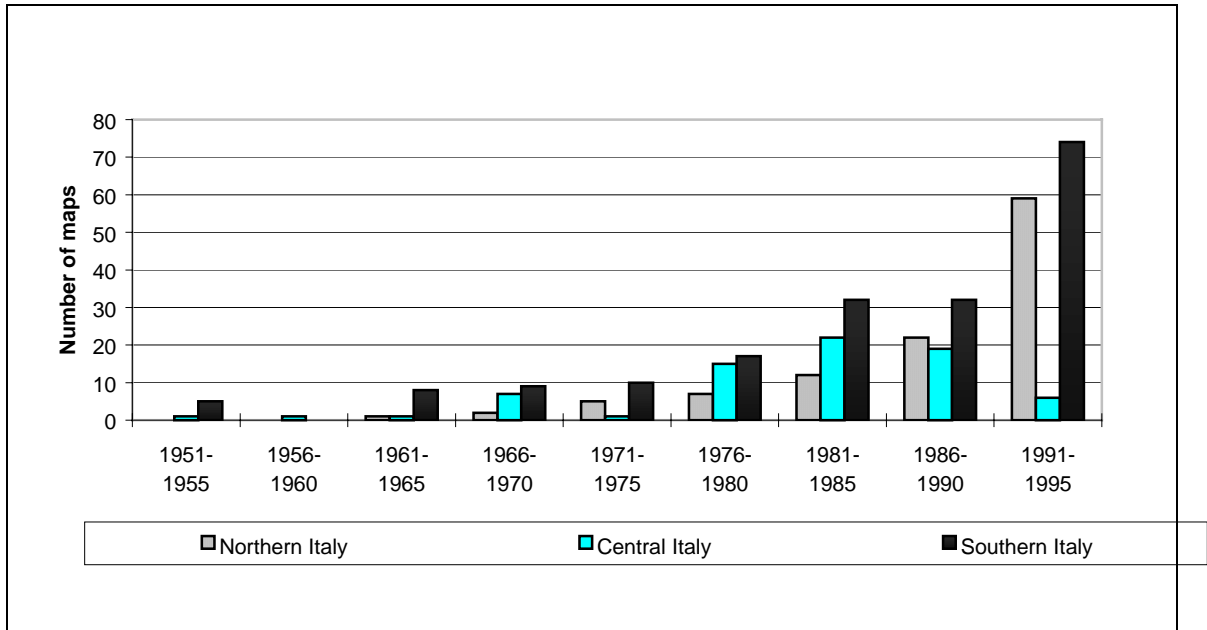


Figure 1: Soil maps produced in Italy since 1950 in each macro-region

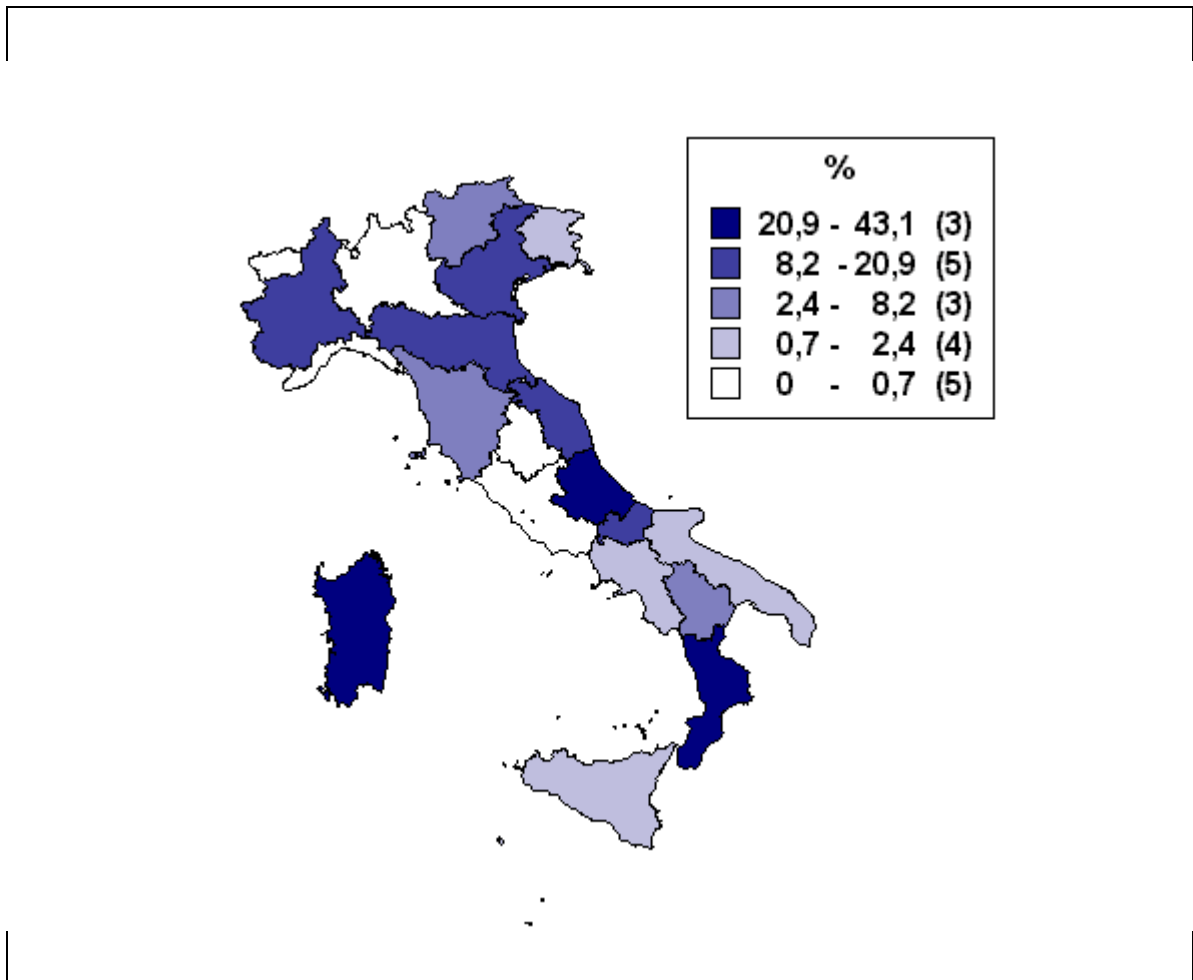


Figure 2: Percentage and (number) of regional territories covered by detailed soil maps.

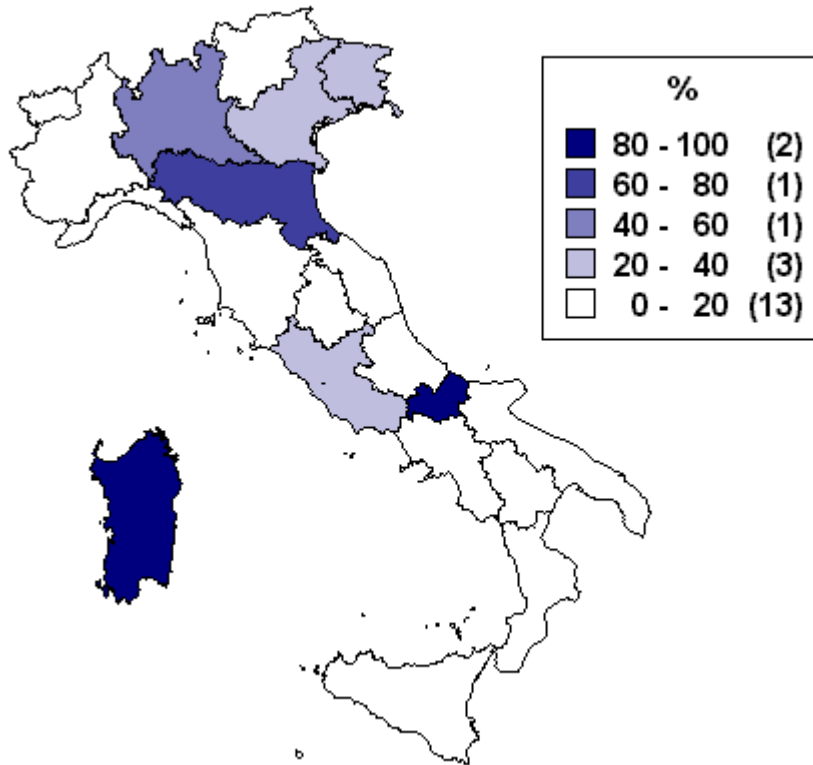


Figure 3: Percentage and (number) of regional territories covered by semi-detailed soil maps

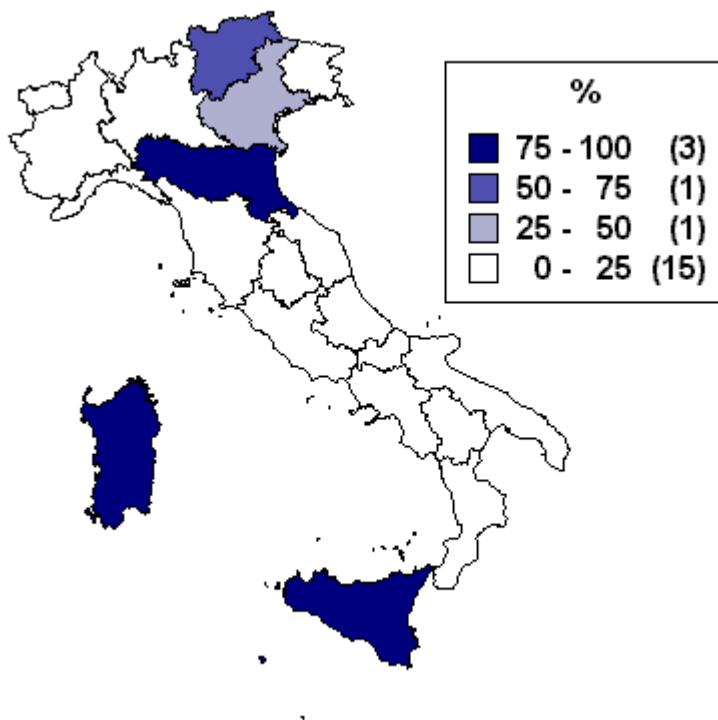


Figure 4: Percentage and (number) of regional territories covered by reconnaissance soil maps

Table 3: Area covered by soil evaluation maps at scales up to 1:250,000

| | Ha | % of total mapped area | % of Italy |
|--|-------------------|------------------------|-------------|
| Land Capability | | | |
| Land Capability | 12,800,969 | 47.6 | 42.5 |
| | 12,800,969 | 47.6 | 42.5 |
| Land evaluation for agricultural crops | | | |
| Suitability for tree crops | 99,959 | 0.4 | 0.3 |
| Suitability for annual crops | 245,295 | 0.9 | 0.8 |
| Suitability for horticulture | 7,596 | <0.1 | <0.1 |
| Suitability for vine | 133,654 | 0.5 | 0.4 |
| | 486,504 | 1.8 | 1.6 |
| Land evaluation for forestry | | | |
| Suitability for forest yield | 60,424 | 0.2 | 0.2 |
| Suitability for forest mechanisation | 7,126 | <0.1 | <0.1 |
| | 67,550 | 0.3 | 0.2 |
| Land evaluation for pasture | | | |
| Suitability for pasture | 158,297 | 0.6 | 0.5 |
| | 158,297 | 0.6 | 0.5 |
| General agronomic evaluation | | | |
| soil management agronomic advice | 1,724,503 | 6.4 | 5.7 |
| soil fertility and potential soil fertility | 475,720 | 1.8 | 1.6 |
| land use limitations | 2,799,418 | 10.4 | 9.3 |
| Vulnerability to soil tillage | 73,219 | 0.3 | 0.2 |
| | 5,072,860 | 18.9 | 16.8 |
| Land evaluation for environmental safeguard | | | |
| Suitability for industrial sewage distribution | 1,376,572 | 5.1 | 4.6 |
| Suitability for slurry spreading | 1,736,018 | 6.5 | 5.8 |
| Suitability for pollutant degradation | 1,592,317 | 5.9 | 5.3 |
| | 4,704,907 | 17.5 | 15.6 |
| Land evaluation for water management | | | |
| soil – water balance | 823,208 | 3.1 | 2.7 |
| water erosion risk | 611,900 | 2.3 | 2.0 |
| Suitability for irrigation | 1,638,335 | 6.1 | 5.4 |
| | 3,073,443 | 11.4 | 10.2 |
| Others | | | |
| Specific interpretations | 531,382 | 2.0 | 1.8 |
| Suitability for engineering | 15,628 | 0.1 | 0.1 |
| | 547,010 | 2.0 | 1.8 |
| TOTAL | 26,911,540 | | |

Applications

As mentioned before, soil survey information is widely applied in Italy, so that almost all soil surveys have a practical purpose. This is the reason why thematic maps are so numerous and the range large (Table 3). Among the different typologies, Land Capability evaluations are the most common, followed by maps produced for agricultural, forest and range purposes.

The main derived cartography for the whole national territory is a Land Capability map (Mancini and Ronchetti, 1968). Some Regional Administrations have produced thematic maps relating to the different local priorities, e.g., Land Capability in Piemonte (Regione Piemonte-IPLA, 1982), geo-environmental risk in Emilia-Romagna (Regione Emilia-Romagna, 1994), soil suitability for irrigation in Sardegna (Arangino *et al.*, 1986).

Table 4: Structure and responsibilities of the “Pedological Methodologies” project

| Sub-project | Sector of Activity |
|-------------|--|
| 1 | Definition of the general concepts and glossary; carrying out of the Italian version of soil manuals; standardisation of the soil data bank attributes; separation of the soil regions, pedo-landscapes and intermediate landscape levels. General coordination of the project. <i>Responsible: Experimental Institute for Soil Study and Conservation.</i> |
| 2 | Publication of the soil survey manual and field file-card; definition of methods of information distribution. <i>Responsible: Emilia-Romagna Region Soil Bureau.</i> |
| 3 | Standardisation of methodologies for the gathering and management of geographic data and its transfer to the GIS; guidelines for the use of aerial photos, satellite and DTM. <i>Responsible: Experimental Institute for Soil Study and Conservation.</i> |
| 4 | Standardisation of the controls for data quality check; criteria of contract definitions with the companies. <i>Responsible: Agricultural Department of the Tuscany Region and Experimental Institute for Soil Study and Conservation</i> |
| 5 | Methodology calibration and validation in the pilot area "plains and low hills of northern Italy". <i>Responsible: Soil Service of the ERSAL (Lombardia Region).</i> |
| 6 | Methodology calibration and validation in the pilot area “central Italy regions”. <i>Responsible: Soil Section of the ARSSA (Abruzzo Region).</i> |
| 7 | Methodology calibration and validation in the pilot area “southern and insular Italy”. <i>Responsible: Soil Section of the SeSIRCA (Campania Region).</i> |
| 8 | Creation of a national centre of soil cartography. <i>Responsible: Experimental Institute for Soil Study and Conservation.</i> |

In recent years there has been an increase in the range of suitability maps, reflecting the spread of environmental and agricultural interests. The general trend appears to be a shift from generic soil evaluation to more specific interpretations, often integrated with the use of more or less sophisticated models.

Future Developments

In the near future, the most important project in soil survey will be the production of a national soil map at a scale of 1:250,000. For this purpose, Italy is planning to invest more than €6 million over two years.

The overall activity will be divided into two main projects, one of which related to soil survey, the other devoted to methodology assessment. The soil survey activity will be steered by regional Administrations and will be an opportunity for setting up regional soil services, where lacking, or to consolidate those in existence.

References

Arangino, F., Aru, A., Baldaccini, P. and Vacca, S. (1986). I suoli delle aree irrigabili della

The project “Pedological Methodologies - Criteria and procedures for the creation and up-dating of the soil map of Italy” is aimed at developing the methodology to support the realisation, management and utilisation of a georeferenced soil data base of Italy. Another main task of the project is to create a national centre of soil cartography, in collaboration with the Regional Administrations, for collection of pedological data and their use for national evaluations.

Standards provided by the project will be defined with the collaboration of researchers and regional officials and will include procedures, manuals, file-cards and software. They will take into account the national and international state of the art, in particular the European Soil Bureau 1:250,000 Georeferenced Database Manual of Procedures (ESB, 1998), and will be calibrated and validated on pilot areas (Table 4).

Sardegna. Regione Sardegna, Ente autonomo Flumendosa. Cagliari, Italy.

Aru, A., Baldaccini, P., Delogu, G., Dessena, M.A., Madrau, S. and Melis, R. (1990). Carta dei Suoli della Sardegna, in scala 1/250.000.

- Assessorato alla programmazione e all'assestamento del territorio, Centro Regionale Programmazione, Dip. Sc. della Terra, Univ. di Cagliari, Italy.
- FAO (1978). Soil map of the world. FAO, Roma, Italy.
- ESB (1998). Georeferenced Soil Database for Europe, Manual of Procedures Ver. 1. European Soil Bureau, Scientific Committee. EUR 18092 EN, 184pp. Office for Official Publications of the European Communities, Luxembourg.
- European Soil Bureau (1998). The soil geographical data base of Europe at scale 1:1,000,000. JRC, Ispra, Varese, Italy.
- Fierotti, G. (1988). Carta dei Suoli della Sicilia. Ist. di Agronomia, Univ. di Palermo e Regione Sicilia, Assessorato Territorio e Ambiente, Palermo, Italy.
- Magaldi, D., Biagi, B., Calzolari, C. and Mancini, F. (1992). The collection and the computerisation of soil mapping data in Italy. Final report on the research convention between the EC DG Viand the Dipartment of Soil Science and Plant Nutrition of the University of Florence. Quaderni di scienza del suolo, vol IV, CNR, Firenze, Italy.
- Mancini, F. (1966). Carta dei Suoli d'Italia. Comitato per la Carta dei Suoli, Firenze, Italy.
- Mancini, F. and Ronchetti, G. (1968). Carta della potenzialità dei suoli d'Italia. Comitato per la Carta dei Suoli, Firenze, Italy.
- Napoli, R., Gardin, L., Costantini, E.A.C. and Fais, A. (1998). Risultati metodologici e operativi del progetto Cartografia Pedologica nelle Unità Operative Territoriali delle regioni meridionali: innovazioni e prospettive. Boll. Soc. It. Sc. del Suolo. XLVII, 3, 393-408.
- Regione Emilia Romagna. (1994). I Suoli dell'Emilia-Romagna. Regione Emilia Romagna, Bologna, Italy.
- Regione Piemonte – IPLA. (1982). La capacità d'uso dei suoli del Piemonte ai fini agricoli e forestali. Ed. L'Equipe, Torino, Italy.
- Ronchetti, G. (1965). Carta dei suoli della Provincia di Trento. Ist. Sper. per lo Studio e la Difesa del Suolo, Firenze, Italy.
- Vianello, G. and Zecchi, R. (1988-1990). Repertorio Cartografico Italiano. vol. 2 e 2b, Pedologia, Ed. Pitagora, Bologna, Italy.