

# **Advances in soil survey, monitoring and applications in Italy**

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## **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 regarding 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, province and communal, many strategies and regulations involve the need for soil survey, for example, in support of increased land productivity, such as that of vineyards and forests, or land planning like “watershed plans”, “management of water resources plans”, “environmental safeguard plans”, “province 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.

Besides the soil survey activities promoted or introduced by public institutions, there are also a number of pedological studies financed by single or associated private bodies. 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 activity. However, the details laid out in this paper should give an idea of much of the development.

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 data bases**

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 free-lance 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: one to five million (FAO-UNESCO, 1978) and one to one million (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. The soil maps of Lombardia and Abruzzo are almost complete, but some other regions are still almost 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 such variety in soil maps, the Committee for the National Observatory for Pedology and Soil Quality planned a work programme to produce a 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 of the Geography Department of the University of Bologna, an integration of data on soil maps has been possible (Magaldi et al., 1992, Vianello et al., 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).

	detailed (scale <= 25,000)			semidetailed (scale between 30,000 and 100,000)			reconnaissance (scale between 150,000 and 250,000)		
	ha	% *	% **	ha	% *	% **	ha	% *	% **
<b>Italy</b>	<b>2,868,527</b>	9.5	40.8	<b>9,686,847</b>	32.1	59.7	<b>9,012,400</b>	29.9	59.1

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

\* = mapped area percentage on total area of Italy

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

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).

Classification system	<i>profiles</i>
Soil Taxonomy only (USDA)	<b>6,902</b>
FAO only (Revised Legend)	<b>96</b>
Soil Taxonomy and FAO	<b>9,369</b>
Italian Classification	<b>510</b>
Total	<b>16,877</b>

Table 2 - soil profiles georeferenced and classified according to different systems

The differences in macro-regional distribution of soil maps over the 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.

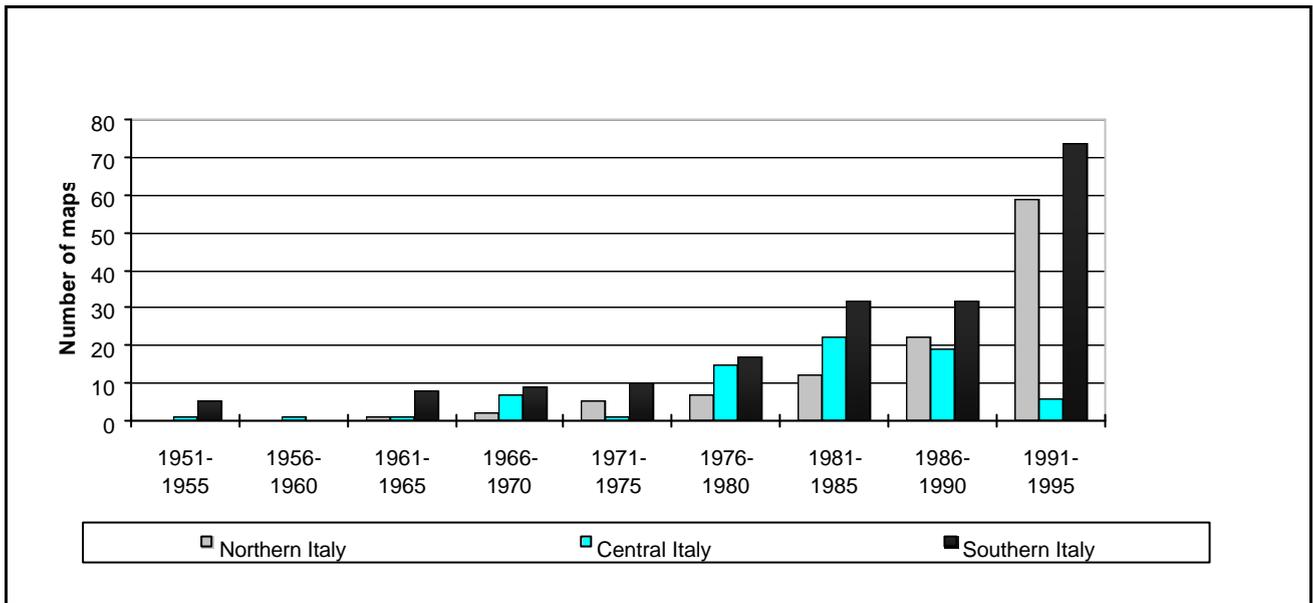


Figure 1 - Soil maps produced in Italy since 1950 in each macro-region.

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

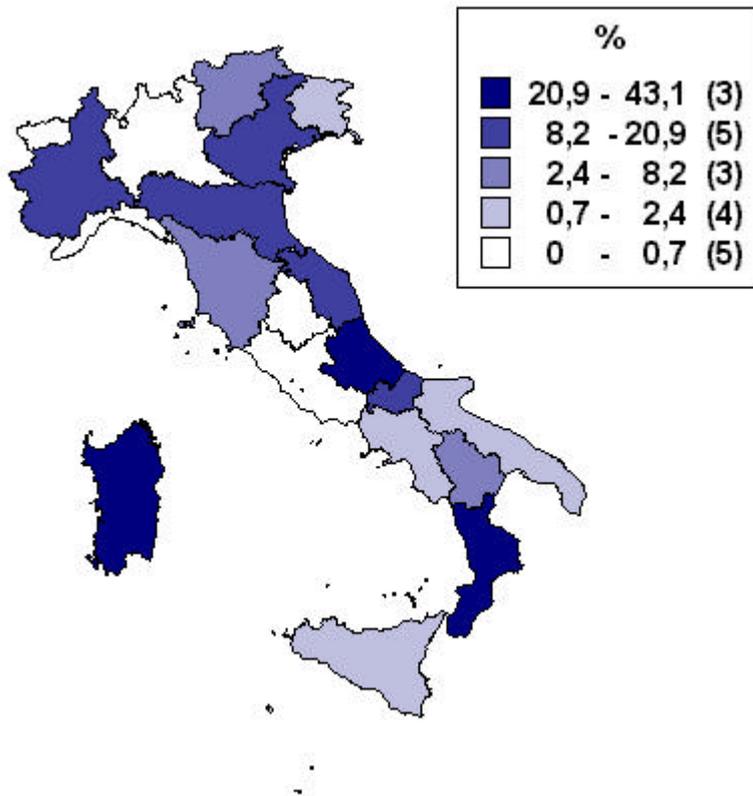


Figure 2 - Percentage and (number) of regional territory covered by detailed soil maps.

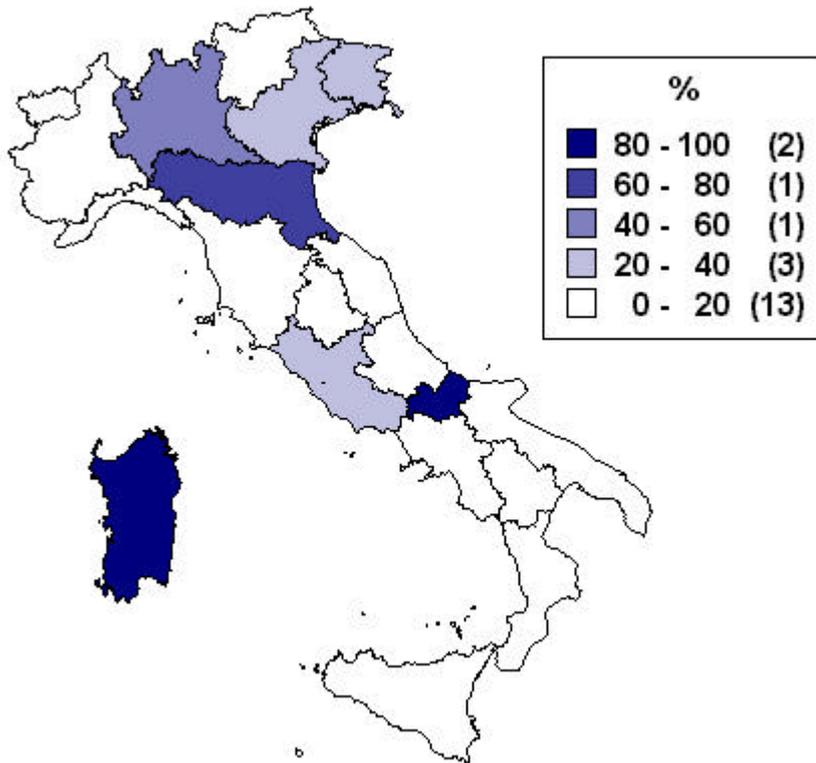


Figure 3 - Percentage and (number) of regional territory covered by semidetailed soil maps.

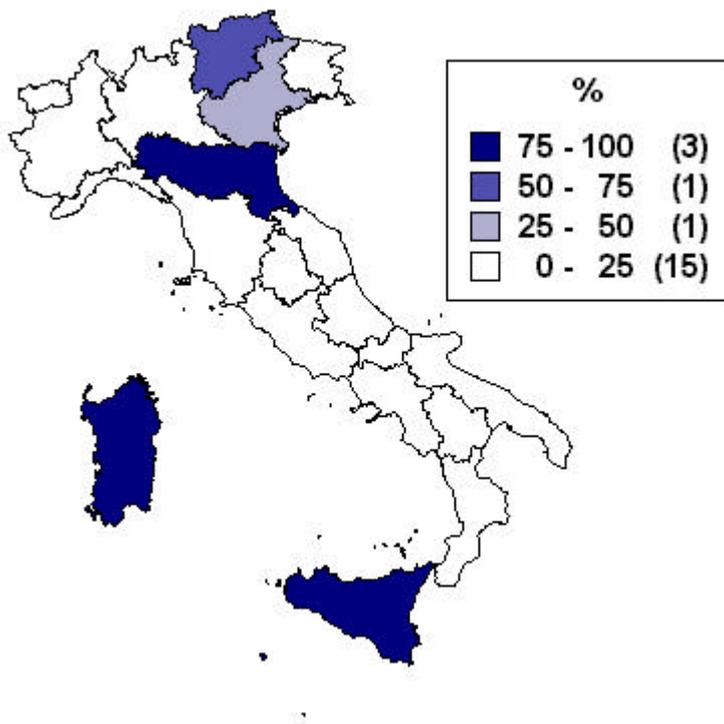


Figure 4 - Percentage and (number) of regional territory covered by reconnaissance soil maps.

## 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.

## 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, 1966). 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).

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.

	ha	% of total mapped area	% of Italian area
<b>Land Capability</b>			
Land Capability	12,800,969	47.6	42.5
	<b>12,800,969</b>	<b>47.6</b>	<b>42.5</b>
<b>Land evaluation for agricultural crops</b>			
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

	<b>486,504</b>	<b>1.8</b>	<b>1.6</b>
<b>Land evaluation for forestry</b>			
suitability for forest yield	60,424	0.2	0.2
suitability for forest mechanisation	7,126	<0.1	<0.1
	<b>67,550</b>	<b>0.3</b>	<b>0.2</b>
<b>Land evaluation for pasture</b>			
suitability for pasture	158,297	0.6	0.5
	<b>158,297</b>	<b>0.6</b>	<b>0.5</b>
<b>General agronomic evaluation</b>			
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
	<b>5,072,860</b>	<b>18.9</b>	<b>16.8</b>
<b>Land evaluation for environmental safeguard</b>			
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
	<b>4,704,907</b>	<b>17.5</b>	<b>15.6</b>
<b>Land evaluation for water management</b>			
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
	<b>3,073,443</b>	<b>11.4</b>	<b>10.2</b>
<b>Others</b>			
specific interpretations	531,382	2.0	1.8
suitability for engineering	15,628	0.1	0.1
	<b>547,010</b>	<b>2.0</b>	<b>1.8</b>
<b>TOTAL</b>	<b>26,911,540</b>		

Table 3: area covered by soil evaluation maps at scales up to 1:250.000

## Oncoming 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 6,000,000 Euro in 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.

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 manual, and will be calibrated and validated on pilot areas (Table 4).

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, pedolandsapes and intermediate landscape levels. General co-ordination 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>

<b>4</b>	Standardisation of the controls for the data quality check; criteria of contracts definition with the companies. <i>Responsible: Agricultural Departement of the Tuscany Region and Experimental Institute for Soil Study and Conservation</i>
<b>5</b>	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>
<b>6</b>	Methodology calibration and validation in the pilot area "central Italy regions". <i>Responsible: Soil Section of the ARSSA (Abruzzo Region).</i>
<b>7</b>	Methodology calibration and validation in the pilot area "southern and insular Italy". <i>Responsible: Soil Section of the SeSIRCA (Campania Region).</i>
<b>8</b>	Creation of a national centre of soil cartography. <i>Responsible: Experimental Institute for Soil Study and Conservation.</i>

*Table 4: structure and responsables of the "Pedological Methodologies" project*

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