The soil map of Italy: a hierarchy of geodatabases, from soil regions to sub-systems

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ABSTRACT: This paper is aimed at showing the organization of the national soil information system managed by the Agriculture Research Council of Italy (Soil Information System of Italy, SISI). The available soil geodatabases for the whole of Italy are those of the soil regions (1:5,000,000), subregions (1:1,000,000), and systems (1:500,000), while the soil subsystems geodatabase (1:250,000) is available for most part of Italy.

1 INTRODUCTION

This paper is aimed at showing the organization of the national soil information system managed by the Agriculture Research Council of Italy (Soil Information System of Italy, SISI). SISI is a Spatial Data Infrastructure which stores geographic and semantic information about soils and soil forming factors, including climate, geology, relief, and land use, at different scales (Tab. 1). At present, the available soil geodatabases for the whole of Italy are those of the soil regions (reference scale 1:5,000,000), subregions (1:1,000,000), and systems (1:500,000), while the soil subsystems geodatabase (1:250,000) is available for most part of Italy. While soil regions and subregions are mainly conceived to give a comprehensive overview of the country pedodiversity, also as printed maps, soil systems and the more detailed levels are more suited for browsing through webgis applications and to derive thematic maps.

2 MATERIALS AND METHODS

The soil information was collected and harmonized from different sources, with the collaboration of the Ministry of Agricultural, Food and Forestry Policies, the soil bureaus of the Italian Regional Administrations, as well by the soil chairs of some Universities. A specific software was created, able to store and correlate data of soil profiles and typological units (STU) coming from different sources (Costantini et al., 2007). The World Reference Base for Soil Resources (IUSS/ISRIC/FAO, 2006) is the main soil correlation system, but soils are also classified following Soil taxonomy (Soil Survey Staff, 2006).

The geography of the soil region geodatabase was created following the European manual of procedures (Finke et al., 1999) on the basis of the main climate and lithology factors of pedogenesis, and allocating main soils to mapping units (Righini et al., 2001). A further generalization was created for printing the map and highlight pedodiversity of the country (Costantini et al., 2012). The geodatabase of the soil subregions instead was created through the generalization of both geography and STU of the soil systems geodatabase following the WRB guidelines (IUSS/ISRIC/FAO 2010).

Table 1. Hierarchy of soilscapes and geodatabases of Italy.

Soilscape level	Reference scale	Reference polygon size
Soil regions	1:5,000,000	10^5-10^6 ha
Soil subregions	1:1,000,000	10^4-10^5 ha
Soil systems	1:500,000	10^3-10^5 ha
Soil subsystems	1:250,000	10^2-10^5 ha
Soil units	1:50,000	10^1-10^2 ha
Soil element	1:10,000-25,000	10^{-1}-10^1 ha

The soil systems geodatabase is at present the main harmonized soilscape level of SISI. Polygons are composed of homogeneous areas with regards to relief, lithology, drainage network, and land cover. There are up to seven land components (LC) in each

polygon of a land system. A “land component” of soil system is a specific combination of morphological class, lithology, and land cover. The linkage between geography and soil was created by allocating to a LC one or more STU, attributing a percentage of coverage. LC were not delineated, but their incidence in the polygon was quantified (Costantini et al., 2013).

The soil subsystems geodatabase was produced for almost all Italy through a geometrical and semantic harmonization of the maps produce by the regional teams. The geographical attributes used in the harmonization were main and secondary lithology, morphological class, and land use. STU produced at the regional level were linked to the soil subsystems, with the assignment of at least a benchmark profile (Napoli et al. 2005).

3 RESULTS AND DISCUSSION

The four geodatabases (Figs. 1-4) show a different but nested generalization of both geographic and soil information. In fact, by downscaling, every polygon inherits the semantic codes of the upper geographic layers, while in upscaling STU either disappear, if considered inclusions, or merge together, in case of similar soils. In this way, broader STU average data belonging to many soil profiles.

4 CONCLUSIONS AND PERSPERCTIVES

The national soil information system currently stores information of 10 soil regions and 11 main soil types, 47 subregions and 143 taxa, 2,184 systems and 1,440 national STU, about 4,200 subsystems and 3,000 regional STU. There are some 14,000 soil profiles linked to the national and to the regional STU.

To model the linkage between LC and STU a prototype geodatabase structure was worked out, using detailed data coming from a correlation analysis between some land surface parameters derived from a 30 m resolution Digital Elevation Model, and existing ancillary maps and raster, as land use and geology.

Available maps and geodatabases are downloadable from http://www.soilmaps.it/ or can be browsed in the webGIS at http://aginfra-sg.ct.infn.it/sisi.

5 REFERENCES

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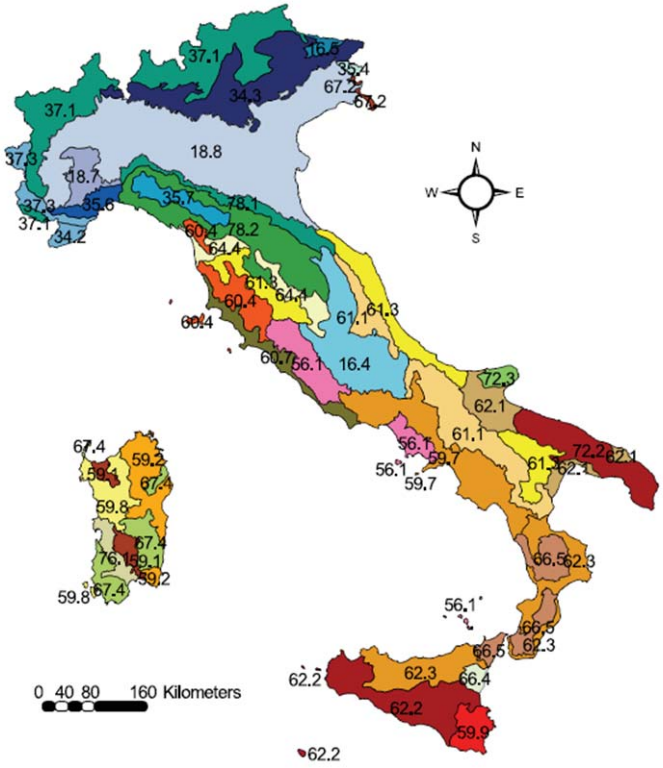

Figure 1. Soil regions of Italy

Figure 2. Soil subregions of Italy

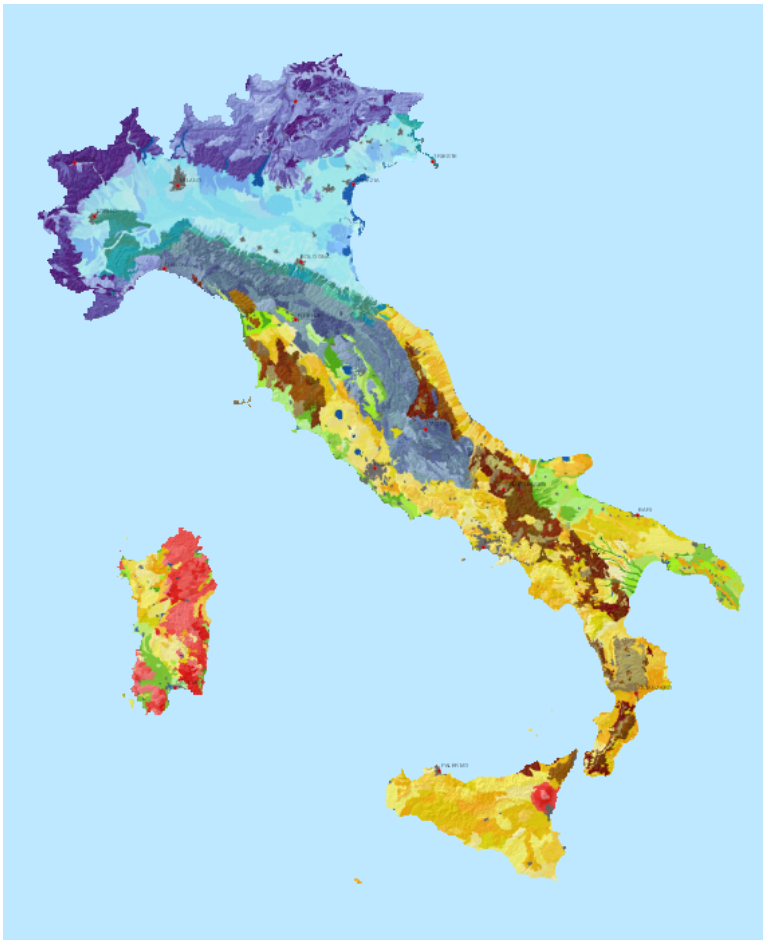

Figure 3. Soil systems of Italy

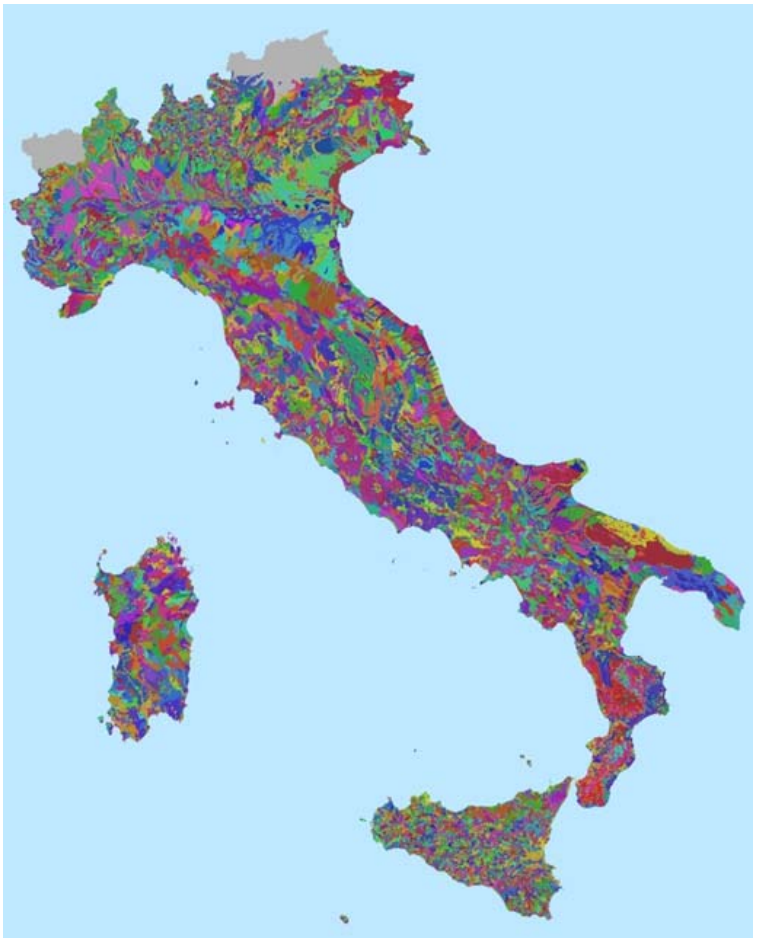

Figure 4. Soil subsystem map of Italy. In grey the not yet harmonized areas.

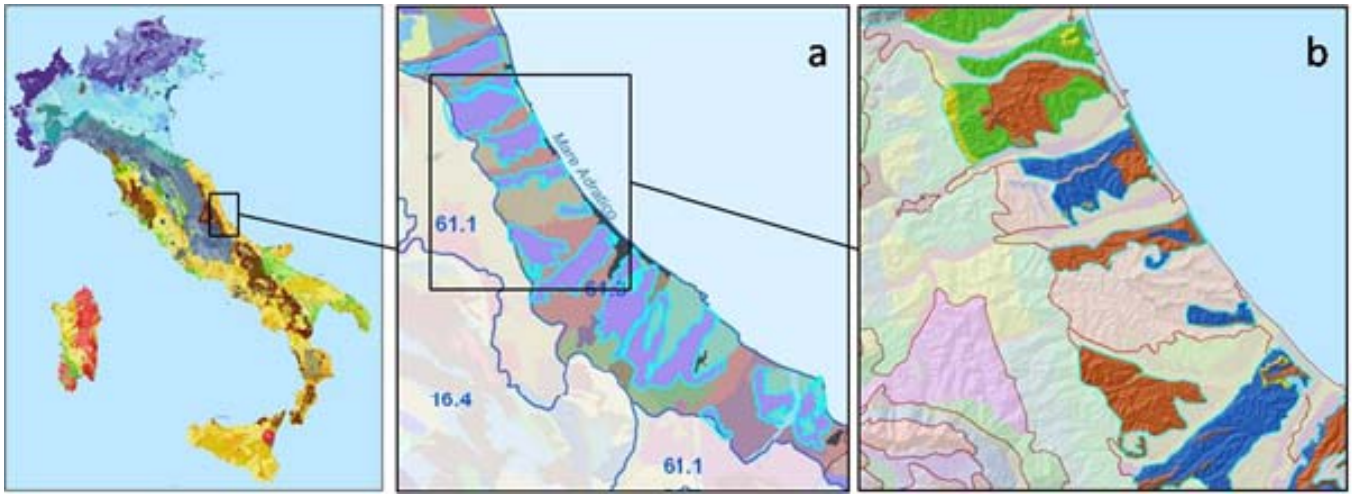

Figure 5. Example of geographic downscaling from soil systems to soil subsystems in the soil regions 61.1 and 61.3 (soil regions E and G in figure 1).

Table 2. Semantic relational table between the soil system and soil subsystem for the example showed in figure 5.

Soil region	Soil subregion	Soil system	Soil subsystem		
			System STU		Soil subsystem STU
61.3	35	84MA204340	61.3CLha2 1	EL_AMP	CST1, TAG1
			61.3CMca2 1	EL_ED_AMP	TAG1, CST1, CST4
				EL_ED_AMP_AMS	TAG1, CST4
				EL_ED_AMR	MAR1, CST1, TAG1
				EL_MT_AMP_AMR	CST1, TAG1, AVA3

Table 3. Extended description for the codes of the relational table 2. The STU Skeletic Luvisols is not visible at the soil system scale and then considered inclusion or similar soils at the higher level.

Entity	Code	Description
Soil region	61.3	Cambisol – Regosol region with Vertisol of central and southern Italy (Tuscany, coastal hills of the Adriatic sea and Lucania hills)
Soil subregion	35	Chromic, Calcic, and Haplic Luvisol; Haplic, Calcic, Chromic, and Hyposodic Vertisol; Haplic Calcisol; Calcaric and Eutric Cambisol; Calcaric Regosol; Calcaric Phaeozem
Soil system	84MA204340	Medium hills with medium gradient with subdendritic to subparallel drainage pattern, on marine clay sediments, covered by row crops (Adriatic lands)
System STU	61.3CLha2 1	Haplic Calcisols of 61.3, fine
	61.3CMca2 1	Calcaric Cambisols of 61.3, fine

Soil subsystem	EL_MT_AMP_AMR	Soilscapes with linear slopes on clayey and silty marine deposits and marine terraces on marine coarse deposits

Soil subsystem STU	CST1 TAG1 AVA3	Calcaric Cambisols - silty clay soils, strongly calcareous, with moderate rooting depth and good internal drainage. Horizons sequence of A-Bw-C type (CST1) Haplic Calcisols - from clayey to clay silty loamy soils, strongly calcareous, with high rooting depth and moderate internal drainage. Horizons sequence of A-(Bw)-Bk-C type (TAG1) Skeletic Luvisols - clayey soils with stony sand layers in depth (within 1 m), moderately calcareous, with moderate rooting depth and good internal drainage. Horizons sequence of A-Bt-Bk-C type (AVA3)