PROJECT FOR AN ITALIAN SOIL MONITORING NETWORK FOR ENVIRONMENTAL PURPOSES: THE EXPERIENCE OF VENETO REGION

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Introduction

There is an increasing need in Europe for harmonised and relevant information about soil status. The European Environmental Agency (EEA) stated that *"information that already exists on soil is patchy, dissimilar and not always easy available among member countries"*; each country has very different type and organisation of that information. In such situation every evaluation of soil status is difficult, especially at European level, where harmonised data are necessary.

According to EEA the development of an assessment framework for soil is needed to bridge the gaps of present programmes on soil at European level.

There is no EU legislation in force that deals with the problems of soil degradation and loss, unlike it happens for air and water; only EU directive on sludge application to soil (86/278/CEE) faced the specific issue of prevention of soil contamination.

The Communication of the European Commission n. 179/2002 "Towards a thematic strategy for soil protection" for the first time gives an overview of soil problems at European level and sets the ground for the future development of an European legislation for soil protection. Some statements of the communication about soil monitoring needing are quite significant: *"For the long-term protection of soils it will be necessary to ensure the development of a more complete information basis, monitoring and indicators to establish the prevailing soil conditions and to evaluate the impact of diverse policies and practices"*.

"The specifications of a Community information and monitoring system on soil threats will be the subject of an appropriate proposal for a soil monitoring legislation. It will aim to ensure that a number of measurements on the identified threats in the relevant areas are carried out in a harmonised and coherent way…".

Conclusions of the Working Group on Monitoring promoted by European Commission in order to set up the Soil Thematic Strategy are very significant, especially where they deal with the needing to identify representative monitoring sites in order to contain costs assuring reliable data on the soil status in Europe.

The final report states that "*monitoring soils is quite different form monitoring air and water. The spatial variability of soils is very high and requires a customised approach that takes this feature fully into account. Soils in Europe are particularly rich and diverse, with many different soil types occurring in different climatic regions, therefore a specific mechanism needs to be developed in order to address this variability. The available information about soil variability can be essentially derived from the 1:1,000,000 scale soil database of Europe available within the European Soil Information System. This data set allows for a preliminary representativity analysis for different monitoring strategies, either grid based and/or stratified.*

Different approaches are required for each of the recognised threats to European soils. Stratification of the European soils according to susceptibility to each of the single threats would allow developing targeted monitoring approaches for each of these.

Future soil monitoring at EU level should be based as far as possible on existing monitoring systems. An in-depth representativity analysis of sites, both for the diversity of soil types and of land uses in Europe, will allow to determine if the existing soil monitoring at National level is adequately covering both soil/landscape diversity for general monitoring purposes and each of the single threats to soils for action driven monitoring purposes".

Following the indications coming from the EEA in 2001 and from the Working Group Monitoring of Soil Thematic Strategy preparatory work, the Italian National Topic Centre (NTC) on Soil and Terrestrial Environment, promoted by the Italian Environmental Protection Agency together with some Regional EPA, worked out a project for a national soil monitoring network (SMN).

The proposal points out that to set out a reliable soil monitoring network there are four fundamental layers of information to be considered:

1. land use (e.g. derived by means of remote sensing);
2. soil typological units and their spatial distribution, as represented in soil maps;
3. results of widespread monitoring data on organic and inorganic contaminants, together with some basic soil characteristics such as pH, organic carbon, CEC;
4. results of monitoring on pressure-impact relationship in some representative sites to increase information about soil degradation processes.

Each of these layers has to be worked out separately but has to be linked to the others to give a complete and exhaustive view of soil conditions through out time. Only this integration allows to reach the objectives of soil monitoring that are:

- integration of knowledge on soil properties and quality;
- collection of data about soil contamination;
- evaluation of changes in soil characteristics in relation to degradation processes;
- diffusion of monitoring results to address policies related to soil protection.

The availability of such basic information requires some actions to be planned, such as description of soil types, identification of land use and definition of standard criteria for the selection of monitoring sites. Furthermore other important issues to deal with are characteristics to be measured, harmonisation of sampling and analysis procedures, methods of reporting and data handling and integration with other monitoring frameworks (water, air, etc.).

Site selection is the first issue in order to build the soil monitoring network; the NTC points out two parallel and complementary approaches based on the type of degradation:

a) systematic investigation on a regular grid: in order to give representative data a large number of sites is required and the number of parameters to measure has to be limited due to costs; it is more suited for monitoring inorganic and organic pollutant contamination;
b) typological approach based on stratification of soils according to land use and soil type; it is more suited for monitoring soil degradation processes (e.g. erosion, organic carbon losses, nitrates and pesticides leaching, etc.) in sensitive areas, but it is feasible to be performed only on few representative sites.

Methodology for the application of a typological approach

The application of the typological approach has to take into account which information is available. As outlined by the NTC guidelines, evaluation of monitoring site representativeness has to consider:

- soil types referred to different pedolandscapes;

- main types of land use;
- combination of soil type and land use;
- different soil degradation processes and different exposition to contamination.

In particular for the soil type the following issues have to be considered:

- soil functional behaviour with regard to main degradation and contamination processes;
- taxonomic classification (USDA Soil Taxonomy and FAO-WRB) trying to group together similar soil types as result of pedogenetic factors (e.g. parent material);
- relations between soil and landscape and between soil and climate, that influence soil functions.

The NTC proposal defines the national key sites, to be used as reference for the national monitoring network and the validation of methodologies, and the reference sites, to be used for the deepening at regional level, that could be also identified as specialistic sites when used for the monitoring of one or more specific threats.

National key sites should be from 1 to 4 for each of 20 italian regions, for a total of 55 sites, while reference sites from 4 up to 37 per region, with a total number of 429 sites; in this way the total number of sites is about 480, with a density of 1 sites each 625 km^2, that is adequate for a 1:250.000 scale (national-European level). Number of sites for each region is reported in table 1.

REGION	Key sites	Reference sites	TOTAL
Abruzzo	2	15	17
Basilicata	2	14	16
Calabria	3	21	24
Campania	3	19	22
Emilia - Romagna	4	31	35
Friuli - Venezia G.	2	11	13
Lazio	3	25	28
Liguria	1	8	9
Lombardia	4	34	38
Marche	2	14	16
Molise	1	6	7
Piemonte	4	37	41
Puglia	3	28	31
Sardegna	4	35	39
Sicilia	4	37	41
Toscana	4	33	37
Trentino-Alto A.	3	19	22
Umbria	2	12	14
Valle d'Aosta	1	4	5
Veneto	3	26	29
TOTAL	**55**	**429**	**484**

Table 1 – Number of key sites and reference sites for each Italian region.

Application of this general scheme for Veneto Region went throughout the following 4 steps:

1) definition of groups of similar soil types on the basis of the soil map at 1:250.000 scale; for each soil type the representative site (profile) was sampled for each horizon and the upper (horizon

A) and lower (horizon C) layers were analysed for heavy metal (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) concentration, in order to acquire information about soil contamination (usual and natural background levels as defined by ISO/CD 19258);

2) selection of 7 main classes out of the 14 Corine Land Cover land use classes representing the more widespread crop systems in the region;
3) selection of principal combinations of soil type and land use;
4) identification of sites positioned in experimental stations.

Results

For the monitoring of diffuse contamination we started analysing each profile sampled in 1:50.000 scale soil survey; the first investigated area is the Venice Lagoon watershed (figure 1) where 470 sites were analysed at two different depths (horizons A and C that means interested or not, respectively, to agricultural operations) for heavy metals concentration.

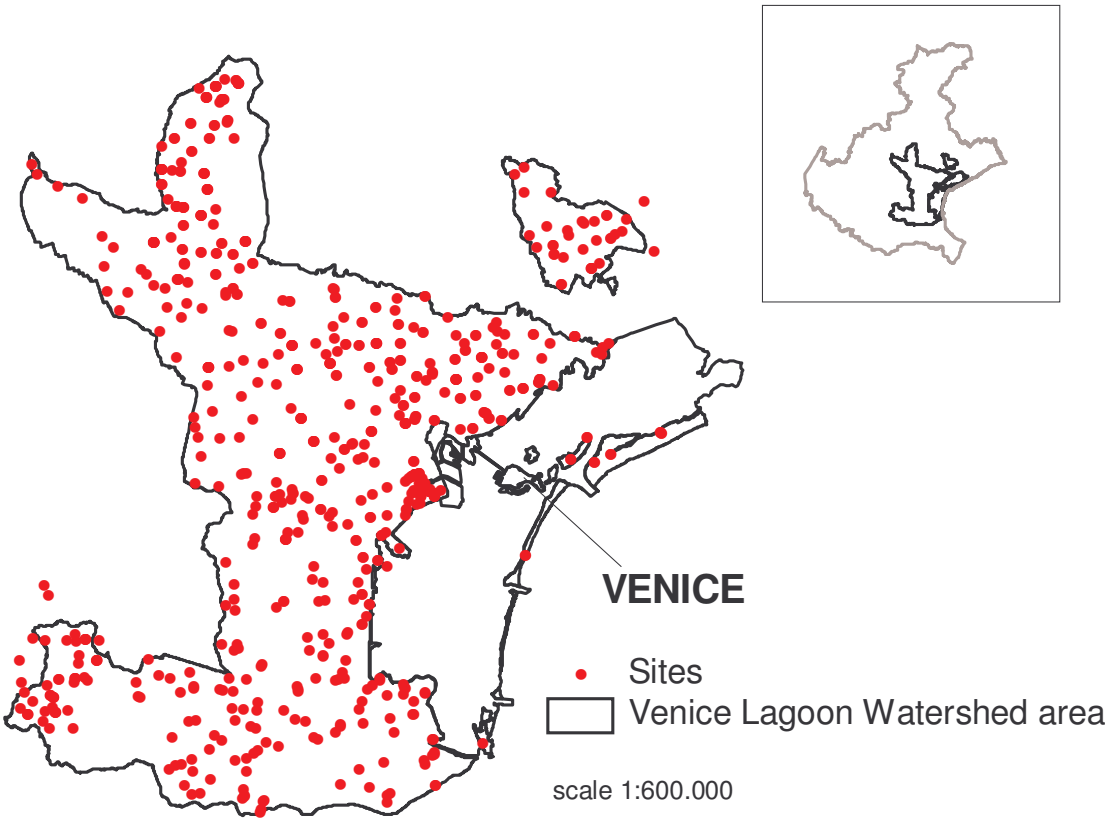

Figure 1 – Sites monitored for heavy metals concentration in Venice Lagoon Watershed area.

Data elaboration is still going on in order to define the background levels (usual and natural) of heavy metals concentration in agricultural soils.

For the monitoring of other soil threats (erosion, loss of organic matter and biodiversity, compaction, salinization) we tried to apply the approach suggested by the NTC guidelines based on the combination of soil type and land use.

The soil map of Veneto Region at 1:250.000 scale contains 56 great soilscapes; the classification was simplified by grouping similar types of soil (figure 2).

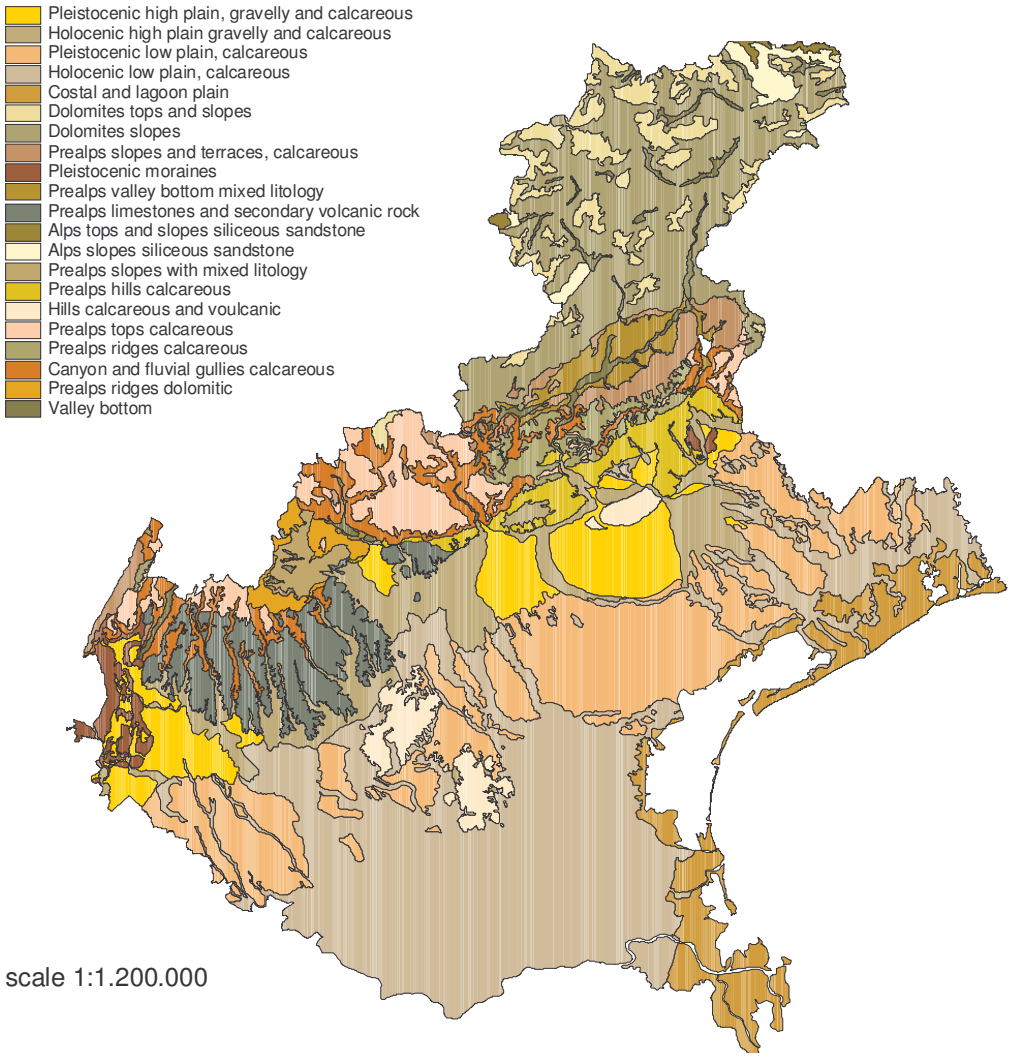

Figure 2 – Main soil types of Veneto Region at 1:250.000 scale.

In particular:

- soils of the mountain area (Alps) were divided in five classes, tops and slopes of Dolomites, tops and slopes of siliceous sandstone mountains and valley bottom;

- in the prealpine area (Preapls) the differences are given by litology (dolomitic, calcareous, volcanic or mixed) and morphology (tops, ridges, slopes, etc.) with six principal groups of soilscapes;
- in the hills area three classes were identified mainly on differences in parent material and climate (Hills and Pleistocenic moraines);
- in the plain the division was made between the gravel high plain and the low plain with finer sediments, with a further division made by the age of formation (Holocenic or Pleistocenic Age); the costal zone constitutes a different group.

For land use the Corine Land Cover classes were grouped on the basis of the prevalent crop system, obtaining in this way 7 classes of land use (figure 3) to which a specific pressure to environment corresponds, being a threats to soil conservation:

- mountain: forest and pastures, cultivated valleys;
- hills: vineyards and forest, arable lands and vineyards;
- plain: arable lands, arable lands and orchards, arable lands and vineyards, grasslands.

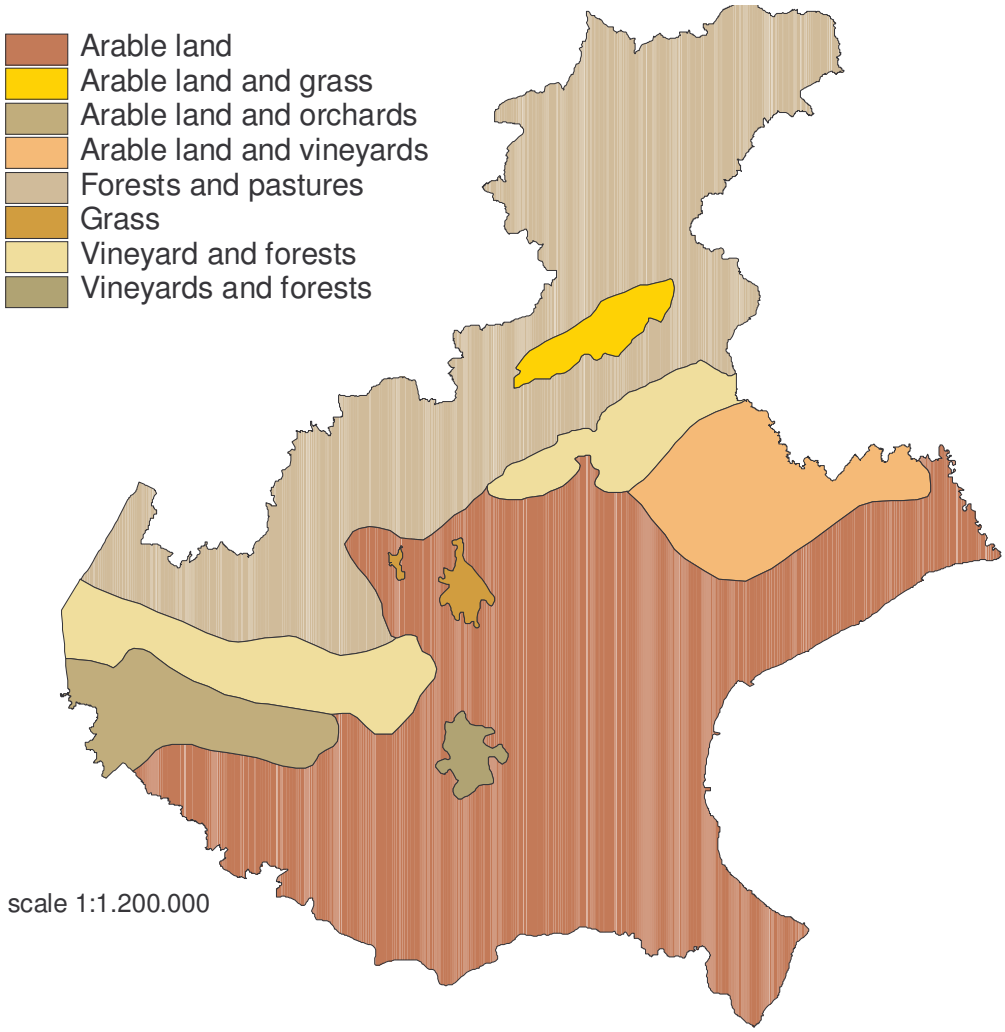

Figure 3 – Main types of land use in Veneto Region.

Combining soil types (21) and land use classes (7) and selecting the more representative combinations, 18 different associations (figure 4) were defined.

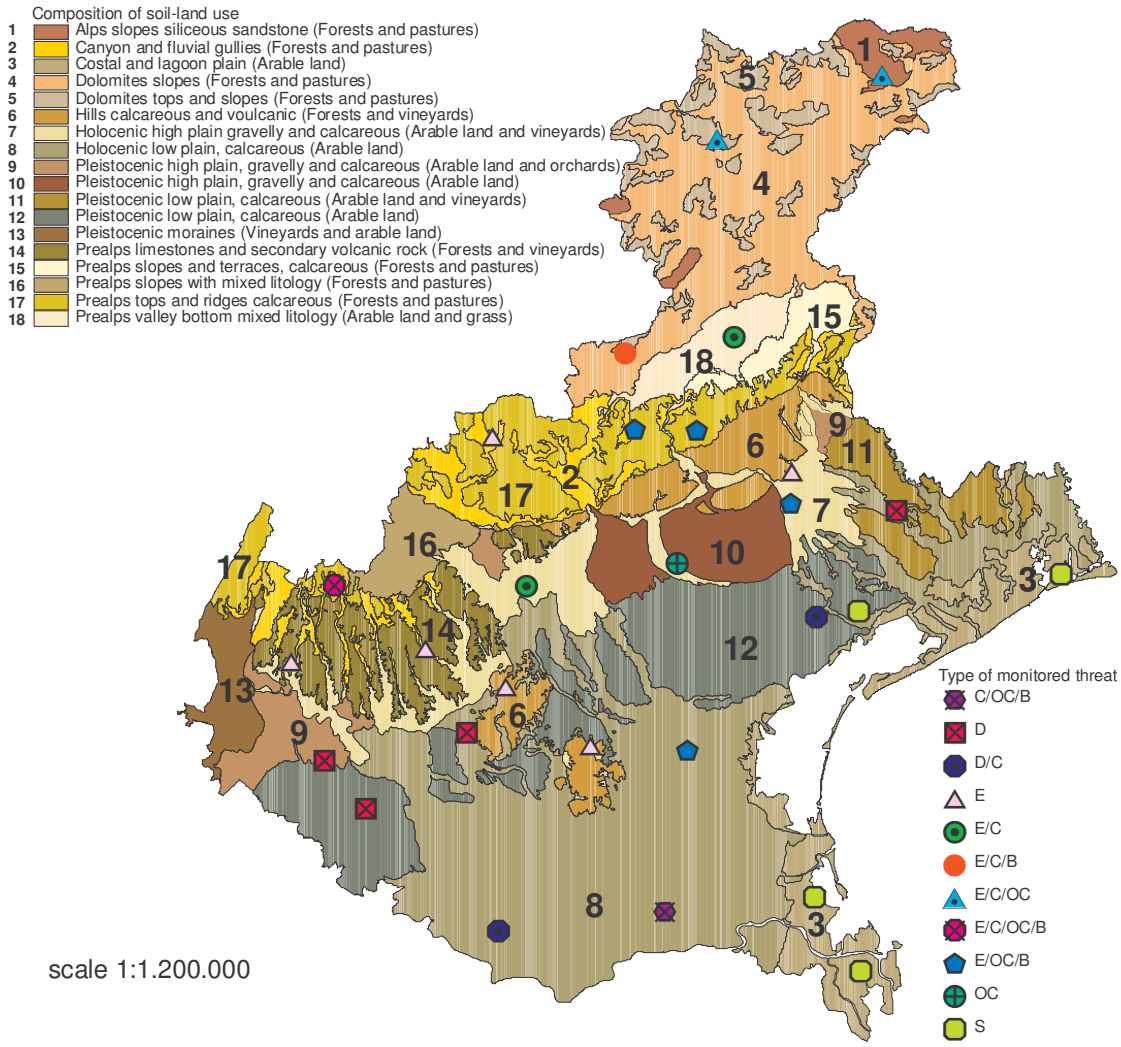

Figure 4 – Main combination soil type-land use and location and type (E=erosion, OM=decline in organic matter, B=decline in biodiversity, D=diffuse contamination, C=compaction, S= salinization), of reference sites selected for soil monitoring network.

For each association, one, two or three sites were selected on the basis of the area extension and distribution; total selected sites were 28 (figure 4), in order to meet the indication given by NTC of a maximum of 29 reference sites in Veneto for the National SMN.

The sites were located preferably in experimental stations managed by National or Regional Institutes that could apply the procedures that have to be defined before activation of SMN.

For each threat some sites are chosen as more representative for monitoring of soil degradation processes in order to stratify sites on the basis of threats to monitor.

In this way each site is identified as fit for one ore more soil threats monitoring activity that have to be defined in the SMN project (figure 4).

Conclusions

The soil monitoring network is not still consolidated in Veneto Region but some activities were started during soil surveys in order to collect data about soil contamination by heavy metals.

Basic information about soil types need to be available in order to identify representative sites for the monitoring of other threats to soil, possibly organised according to standard methodologies that allows international harmonisation (i.e. the Georeferenced Soil Database for Europe, Manual of Procedures by European Soil Bureau, 1999).

Application of the methodology for the identification of representative sites for soil monitoring network on the basis of combination of soil type and land use allows to find out the best possible sites location for future Soil Monitoring Network, taking into account the needs for the integration of such regional network with other networks to create a unique national and european network to be used for the development of soil protection policies.

This methodology for the stratification of soil monitoring sites seems to be a useful tool in order to give a simple and comprehensive overview that is essential for a correct interpretation of monitoring results.

References

ANPA - CTN_SSC (2001). Elementi di progettazione della rete nazionale di monitoraggio del suolo a fini ambientali. Rapporti APAT, RTI CTN_SSC n. 2/2001.

European Environmental Agency (2001). Proposal for a European soil monitoring and assessment framework. Technical report n. 61, pp. 58.

European Commission (2002). Towards a thematic strategy for soil protection. COM 179/2002.

European Commission (2004). Soil Policy. Executive summary of the Final report from Working Group Monitoring. In the website:http://forum.europa.eu.int/Public/irc/env/soil/library
European Soil Bureau (1999). Georeferenced Soil Database for Europe. Manual of Procedures, Version 1.1. EUR 18092EN.

Heymann Y., Steenmans C., Croissille G., Bossard M. (1994). Corine Land Cover – Tecnical Guide. Office for Official Pubblication of the European Communities, Louxembourg.

Giandon P., Vinci I., Fantinato L. (2000). Heavy metal concentration in soils of the Basin draining in the Venice Lagoon. In: Bollettino della S.I.S.S. 49 (1-2) pp. 359-366

Vinci I., Garlato A., Mozzi P., Sartori G. (2003). Soil map at 1:250.000 scale of the Veneto Region: working methods in a multiscale approach. Proceedings of 4th European Congress on regional Geoscientific Cartography and Information Systems, Bologna June 17-20th 2003, Volume I pp. 133-135.