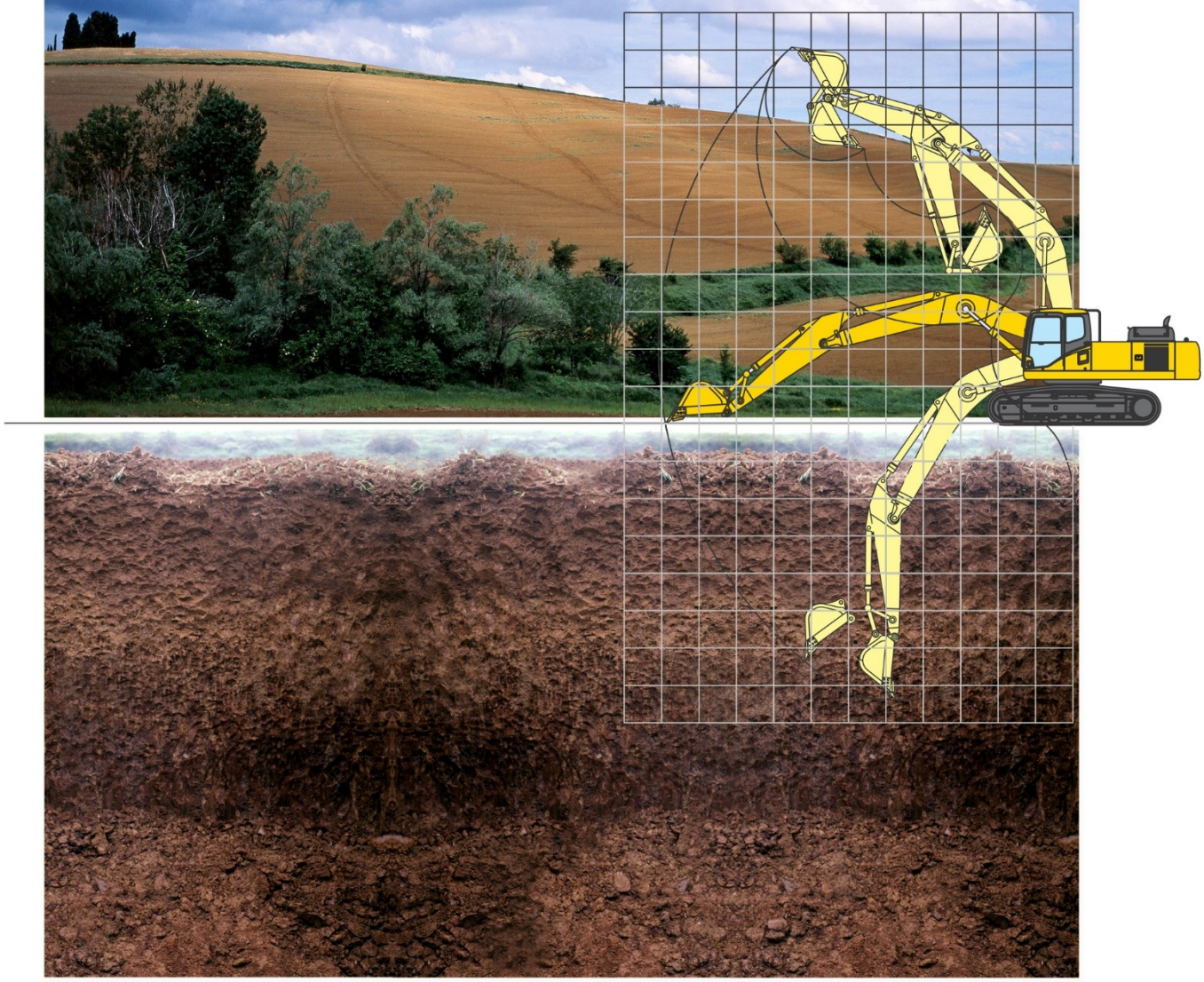
Guidelines for the removal, management and re-use of topsoil at construction sites
ACTION B.2.4



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The present text is composed of various parts addressing the following: soil characterization on construction sites; major soil types in the different environments of the Emilia-Romagna region; an in-depth analysis of the measures that can be implemented for a more effective reuse of topsoil; the integration of regulatory parameters of characterization with those necessary to highlight soll qualities through the identification of topsoil quality classes coupled with the soil maps of the Emilia-Romagna; indications on possible re-uses based on soil intrinsic quality rates; examples of exchange platforms for already existing excavated soils and rocks and potentially applicable at the municipality scale for topsoils; and a vade mecum for site workers.

Legal value of the publication

This publication is a tool to support the execution of the de-sealing activities proposed and implemented in the framework of the B2 action of the SOS4Life project co-funded by the European Union under the LIFE.ENV/IT/000225 program. It is primarily intended for public bodies dealing with land management and for technicians (i.e. construction and earthmoving companies, construction technicians, agronomists ...). This urban planning operation, which the new regional law of Emilia-Romagna addressing the use of land (LR 24/2017) promotes as a measure of compensation for land take, falls within the application of environmental legislation on management of excavated soils and rocks (Presidential Decree 120/2017) and the one on waste (Legislative Decree 152/06). The text gives concrete form to legal concepts, with the aim of standardizing their practical implementation, allowing the adoption of flexible and adequate solutions.

Its application is on a voluntary and non-binding basis.

It is up to the Municipalities the possibility of incorporating this text, wholly or in part, into the urban planning tool or as an ad hoc regulation, in order to make it binding.

The following guidelines are recommended in the context of the implementation of contracted production interventions (see Article 6 paragraph 6 of Regional Law 24/2017) involving the possible deduction of the value of the works from the construction aid (see Article 6) paragraph 6 of Regional Law 24/2017).

Introduction

Aims of the publication

This publication aims to:

1. Promote the limitation of soil sealing (as suggested by the EU Guidelines on best practice to limit, mitigate or compensate soil sealing, SWD\2012\101);
2. Create a circular economy within which soils excavated during the realization of construction works and infrastructures are re-used, within a short distances and preferably in the same municipality, in areas for urban re-use and regeneration, as defined by the art. 7, paragraph 4 of Regional Law 24/17[1];
3. Value soil and facilitate its reuse in the production and management of excavation materials for building works and infrastructures in application of Presidential Decree 120/2017 and Directive 851/2018;
4. Limit the use of soil improvers in urban green areas.

[1] *Pursuant to paragraph 4 of art. 7 of the Regional Law 24/17 "The following types of building and urban transformations of the existing urban fabric are considered interventions of urban re-use and regeneration:*
a) "building qualification" interventions, aiming at carrying out the demolition and reconstruction of one or more buildings of poor construction quality, not meeting the minimum requirements for energy efficiency, seismic safety, elimination of architectural barriers, sanitary facilities and facilities safety, established by current legislation, as well as conservative interventions that, without requiring the demolition of the original building, allow in any case to achieve improvements in energy efficiency, seismic safety and other technical requirements required by current legislation for building conformity to standards. Subject to the discipline for the protection of the historic center and buildings of historical, artistic and testimonial value referred to in Article 32, paragraphs 5, 6, 7 and 8, building qualification interventions are always permitted and are implemented with direct intervention, subject to any limits and conditions established by the General Urban Plan (GUP);
b) "urban restructuring" interventions, as defined in letter h) of the annex to the regional law of 30 July 2013, n. 15 (Simplification of building regulations), including construction and subsequent demolition, governed by Article 13 of this law, which are implemented through a building permit agreement;
c) interventions of "urban densification or substitution", consisting in upgrading processes, including incremental ones, which, with particular reference to strategic areas of the city or to degraded, marginal, decommissioned or scarcely built areas, envisage their significant transformation involving, for example: the modification of the design of lots, blocks, open spaces and road network; the relocation of properties located in areas subject to environmental and industrial risk; the demolition without reconstruction of buildings located in areas characterized by an excessive settlement concentration, with the possible transfer of planned edification according to the indications of the GUP; the insertion of new functions and the realization or adaptation of territorial endowments, infrastructures and public services as well as the implementation of social housing projects. These actions aim to revitalizing and qualifying the territory from an identity, social and economic point of view, creating new attractiveness and opportunities for development. Urban densification or replacement measures are implemented through operational agreements or public initiative implementation plans referred to in Article 38 ".

1. Definition of soil

Soil, which is synonymous with the term "land", has different meanings depending on the different people interested in it. For a farmer, the soil is a more or less large portion of the earth's surface that can be exploited in view of a plant and/or animal production. For a geologist, a series of layers or rocks that can be dated to a certain period of the existence of our planet. For an engineer, the soil is a rock or a sediment that must be taken into account for earth-moving, foundation and construction operations. For a botanist and a naturalist it is the support of plant and animal life, for a gravel quarry worker it represents the diaphragm to be removed in order to start exploiting the material with a lithoid function. For the pedologist, soil is the product of weathering, of the change and organization of the upper layers of the earth's crust, under the action of life, of the atmosphere and of the exchanges of energy manifested therein (Giordano, 1990). Soil is a three-dimensional body, inhabited, functional and structured, a complex and heterogeneous environment: in addition to the minerals produced by meteoric weathering, as well as organic material resulting from the degradation of plant material, soil is in fact also composed of water, air and a universe of living organisms that performs many ecosystem functions for humans (Figure 1).

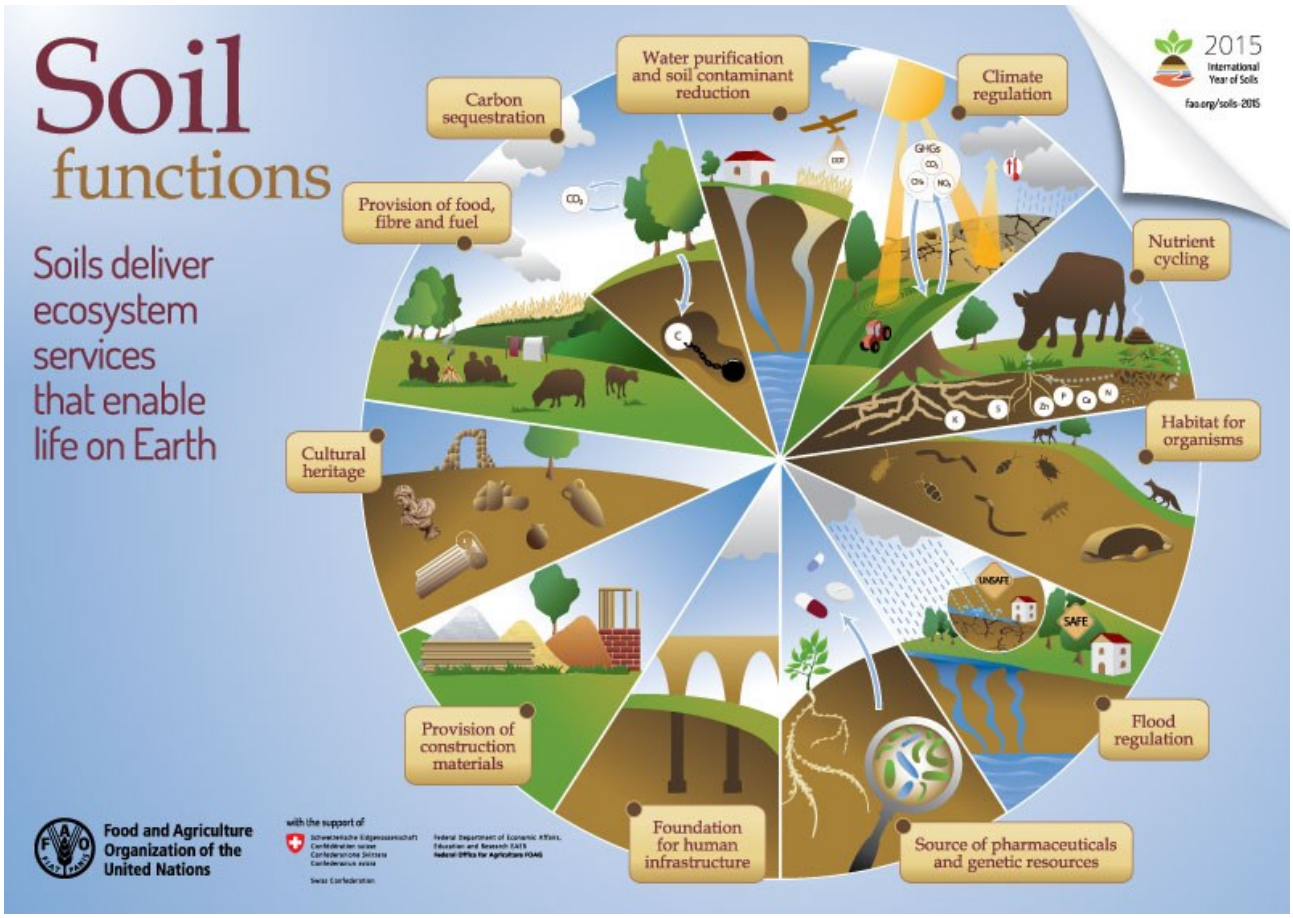


Figure 1. Soil functions and ecosystem services (Source: FAO, 2015).

Soil organization is represented by the sequence of its horizons that develop from the surface at contact with the atmosphere; they are termed A, B and C horizons from top to bottom, where, with the letter A we indicate organ-mineral horizons, with the letter B mineral horizons (in both the

weathering processes of the original material are already in place) and with the letter C the substrate in which the weathering is in the initial phase (Figure 2).

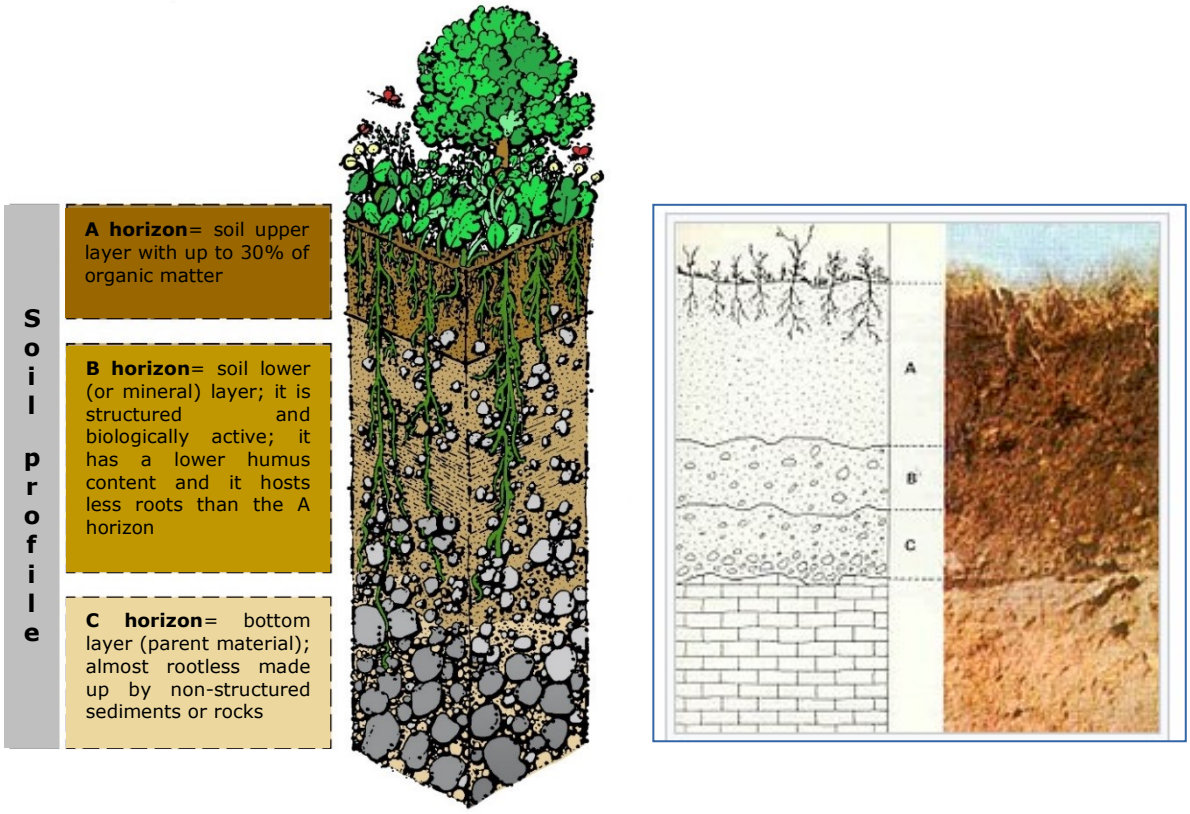


Figure 2. Soil organization and horizons sequence (Sources: UFAFP, 2001; WIKIPEDIA).

On construction sites, the different backgrounds and skills of the technicians who deal with soil make it necessary to translate the scientific terms in more operational terms that still allow the recognition of soil horizons and the distinction of topsoil from subsoil (table 1, Figure 3).

Pedology	Construction site
A Horizon (organo-mineral)	Dirt / vegetable soil
B Horizon (mineral)	Dirt / inert soil
C Horizon	Digging material
Rock /sediment	Rock / sediment

Table 1. Terminology comparison.

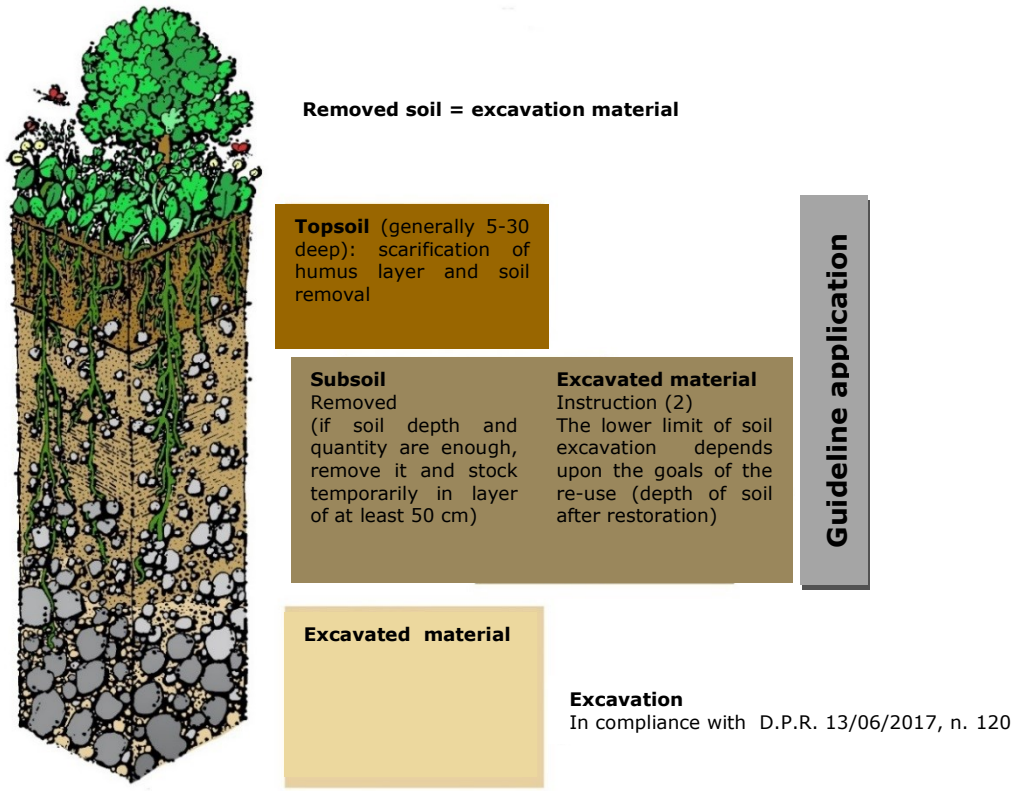


Figure 3. Construction site terminology (Source: UFAFP, 2001, mod.).

From the legislation point of view, there are further definitions of soil to deal with when managing soil on construction sites (Table 2 and 3).

DPR 120/17*	D.lgs 152/06**	LR 24/2017***
"Soil": the most superficial layer of the earth's crust between the rocky substratum and the surface. The soil is made up of mineral components, organic matter, water, air and living organisms, including reporting materials matrix according to article 3, paragraph 1, of the decree-law of 25 January 2012, n. 2, converted, with amendments, by law of March 24, 2012, n. 28.	"Soil": the most superficial layer of the earth's crust located between the rocky substratum and the surface. The soil is made up of mineral components, organic matter, water, air and living organisms. For the sole purpose of applying the Third Party, the meaning of the term includes, in addition to the soil as previously defined, also the land, the subsoil, the inhabited areas and infrastructural works.	"common good and non-renewable resource that performs functions and provides ecosystem services, also in relation to prevention and mitigation of geo-hydrological events and to mitigation and adaptation strategies to climate change".

Table 2. Regulatory terminology comparison: definition of soil.

* *art.2 paragraph 1, letter b)*
** *Part two, Title I, art. 5, paragraph 1, letter v-quater*
*** *art. 1 paragraph 2 letter a)*

Pedology	D.lgs 152/06- 2*	DPR 120/07**	LR 24/2017
A horizon (organo-mineral ~0-50 cm)	Superficial soil (0-1 m)	Superficial soil (0-1 m)	nd
B horizon (mineral~50-100 cm)			
C horizon (>100cm)	Deep soil > 1 m to groundwater level	Deep soil (1-2m)	
Rock /sediment	Underground	Excavation bottom	

Table 3 Regulatory terminology comparison: soil depth.

** Annex 1 - General criteria for the analysis of site-specific environmental health risk "Routes and methods of exposure", paragraph "Land".*
*** Annex 2 - Sampling procedures during the design phase.*

1.1. Soils of Emilia-Romagna

The regional soils of Emilia Romagna, at a very general level, are distinguished in soils of the Apennine relief and lowland soils, the former mainly affected by erosion processes, the latter mainly by sedimentation processes.
The **soils of the Apennine** relief cover a total area of 10,800 Km^2 and occupy an area that extends from the lowest hills to the Apennine ridge; they are distributed according to a particularly complicated mosaic due to a variety of orographic, geological, geomorphological, climate and vegetation factors and often vary over short distances.
Based on the main evolutionary processes, related to climatic and morphodynamic factors, the soils of the relief are subdivided into: soils of the lower Apennines (200-600 m a.s.l.), soils of the mid-Apennines (600-900 m a.s.l.) and soil of the high Appennines (900 - 2200 m a.s.l. - Figure 10).
The **soils of the plain** cover an area equal to 9.950 Km^2 and occupy a continuous area, which extends from the Po river and from the Adriatic coast up to the wide valley bottoms and to the alluvial terraces of the Apennine margin.
They were formed on mineral sediments with variable texture, mostly medium and fine, with a high fraction of alterable minerals and carbonates. In the meandering plain (Figure 4) and in the delta plain (Figure 6) the sediments come from the Po river; in the valleys and reliefs of the alluvial plain and in the terraces of the Apennine margin (Figures 7, 8 and 9) the sediments come from the Apennine rivers, while in the coastal plain (Figure 5) they come from both the Po river and the Apennine rivers.
In general, the lowland soils do not have, except those of the Apennine margin, a strong degree of weathering with respect to the original sediments due to the relatively recent era of sediment deposition and drying up of the morphological depressions from the marsh waters. However, modifications of many properties (e.g. structure, porosity, pH, OM content) of the surface horizons are significant as a consequence of reclamation interventions and current agricultural practices (soil tillage, irrigation, drainage, fertilizer inputs, phytosanitary products, etc.).
Current knowledge on soils are supported by over 150,000 soil observations with field description, ca. 36,000 of which complete with the laboratory analyzes stored in the Soil Database of the Emilia-Romagna Region. Furthermore the database stores the archive of the soil types of the Region (STU) with the description of the distribution of soils in the landscape at different scales of representation (Cartographic Units). Reference maps are soil maps (scale of 1: 250,000; 1: 50,000; 1: 10,000) as well as the thematic and derivative maps, all disseminated on the websites of the Geological and Seismic Geological Survey http://geo.regione.emilia-romagna.it/cartpedo/
http://ambiente.regione.emilia-romagna.it/geologia/cartografia/webgis-banchedati/webgis-suoli
and on the minERva portal
https://datacatalog.regione.emilia-romagna.it/catalogCTA/

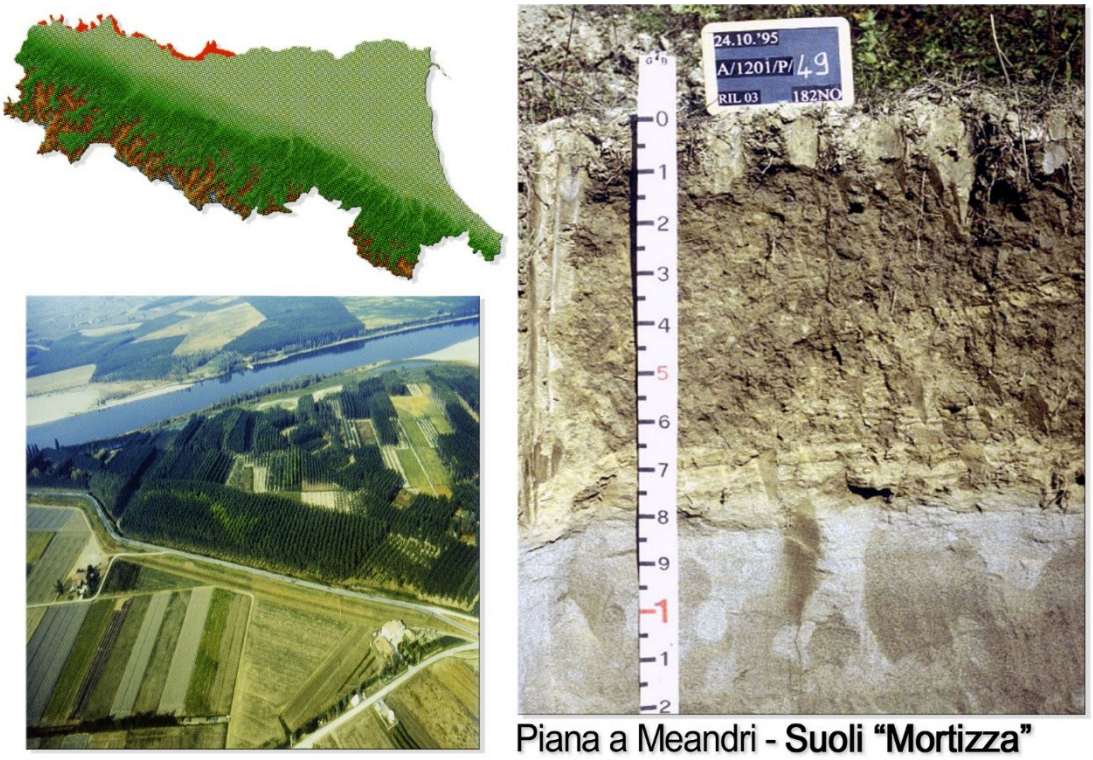


Figure 4. Meander plain: area, landscape and profile of a representative soil.

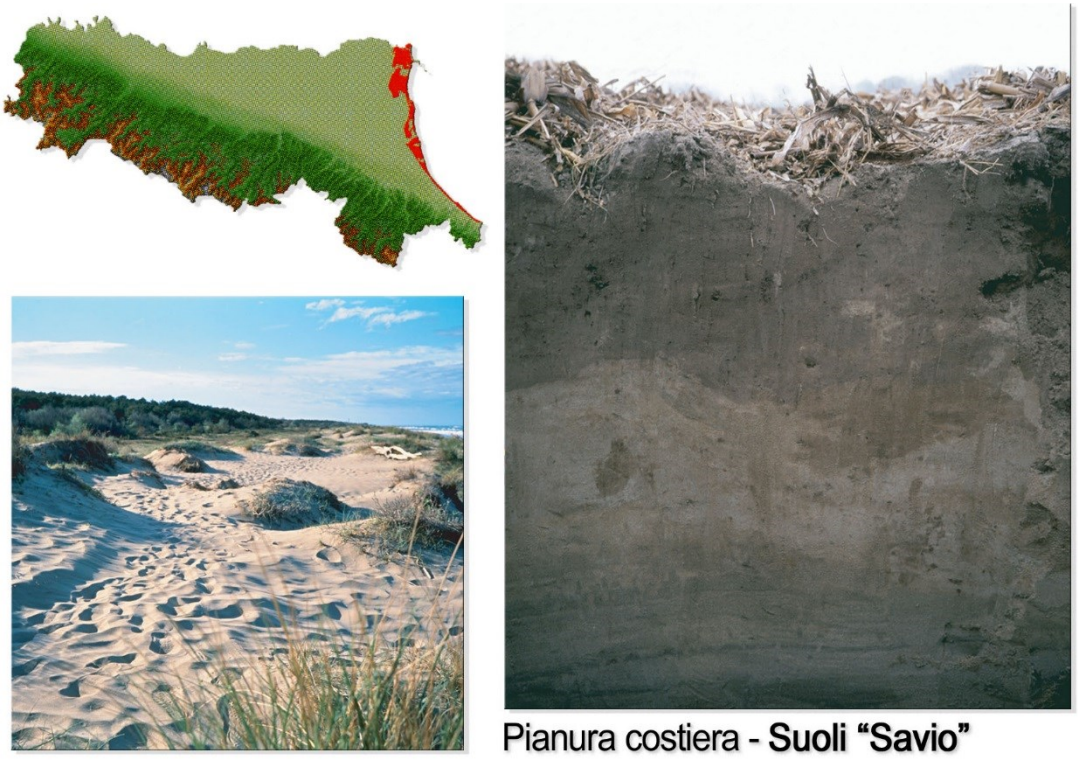


Figure 5. Coastal plain: area, landscape and profile of a representative soil.

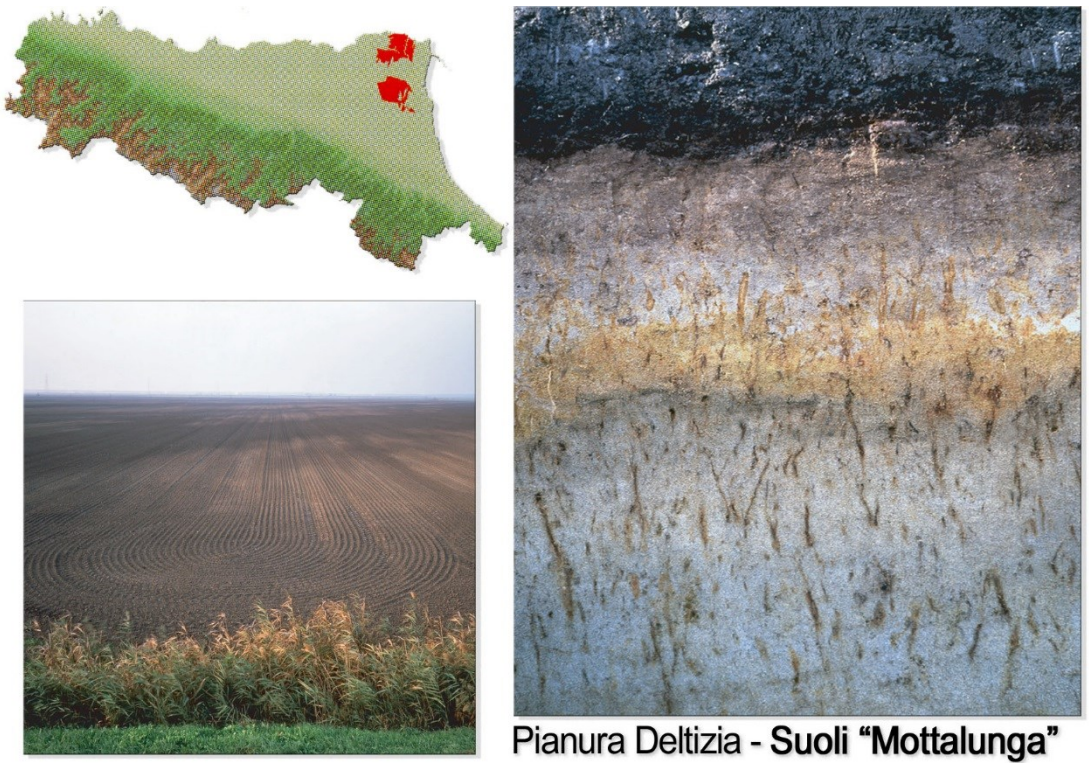


Figure 6. Delta plain: area, landscape and profile of a representative soil.

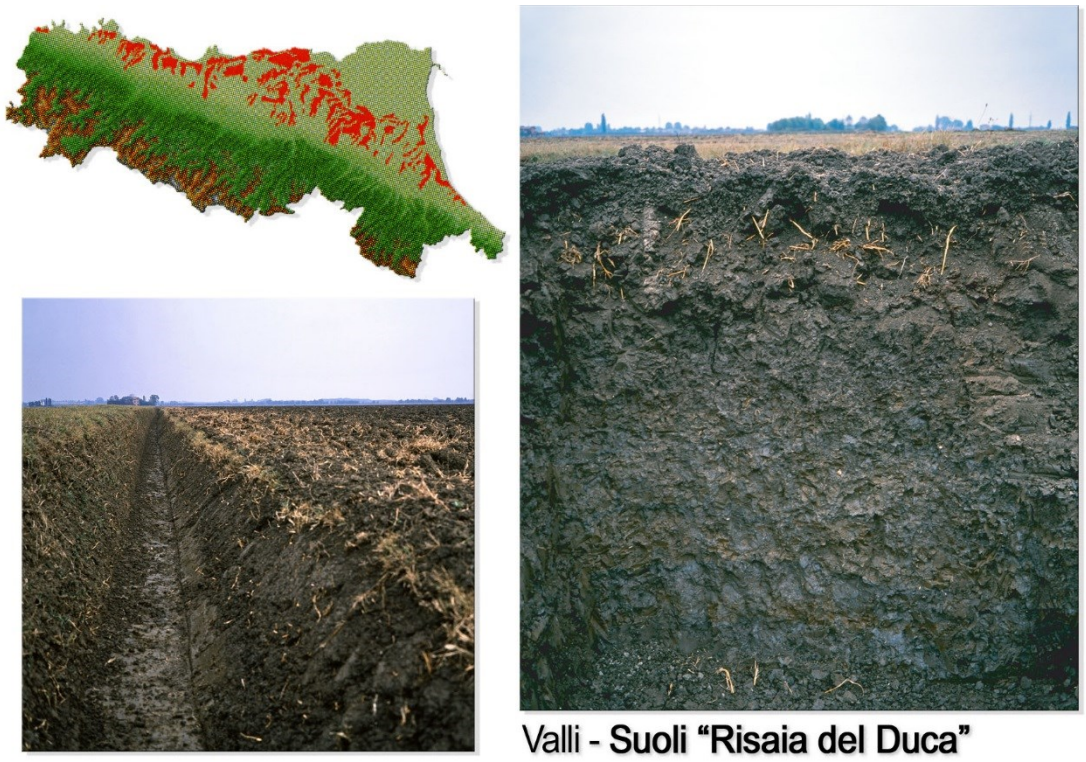


Figure 7. Valleys of the alluvial plain: area, landscape and profile of a representative soil.

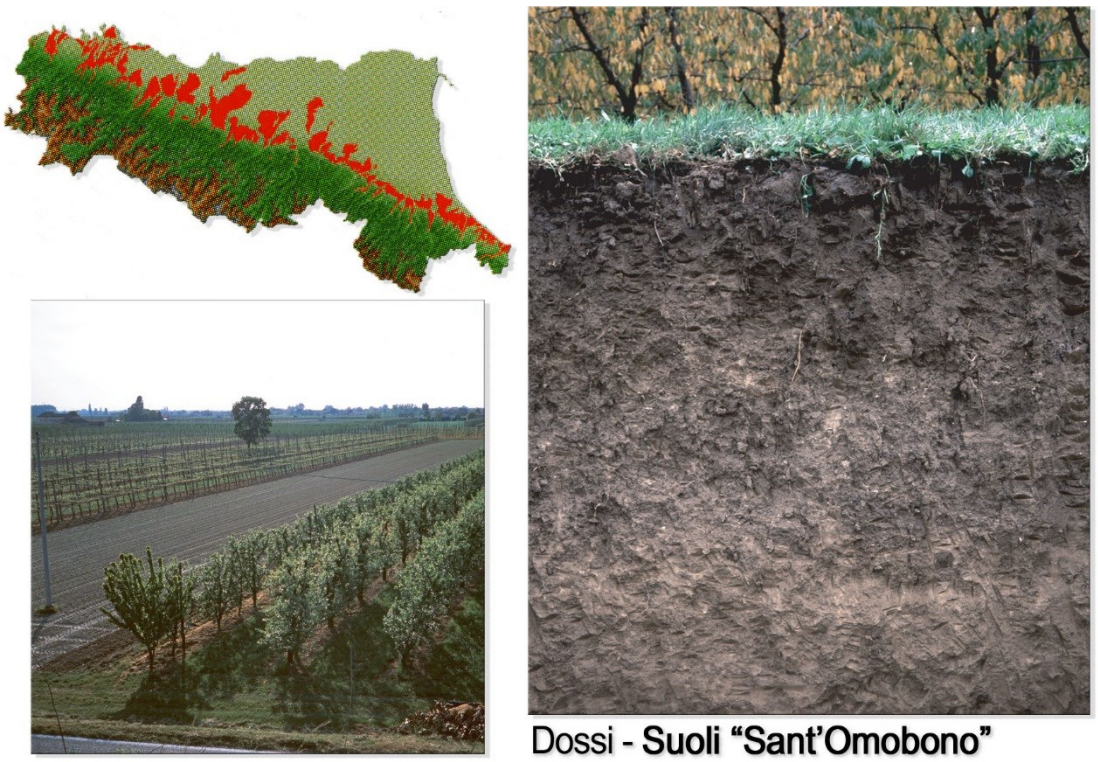


Figure 8. Reliefs of the alluvial plain: area, landscape and profile of a representative soil.

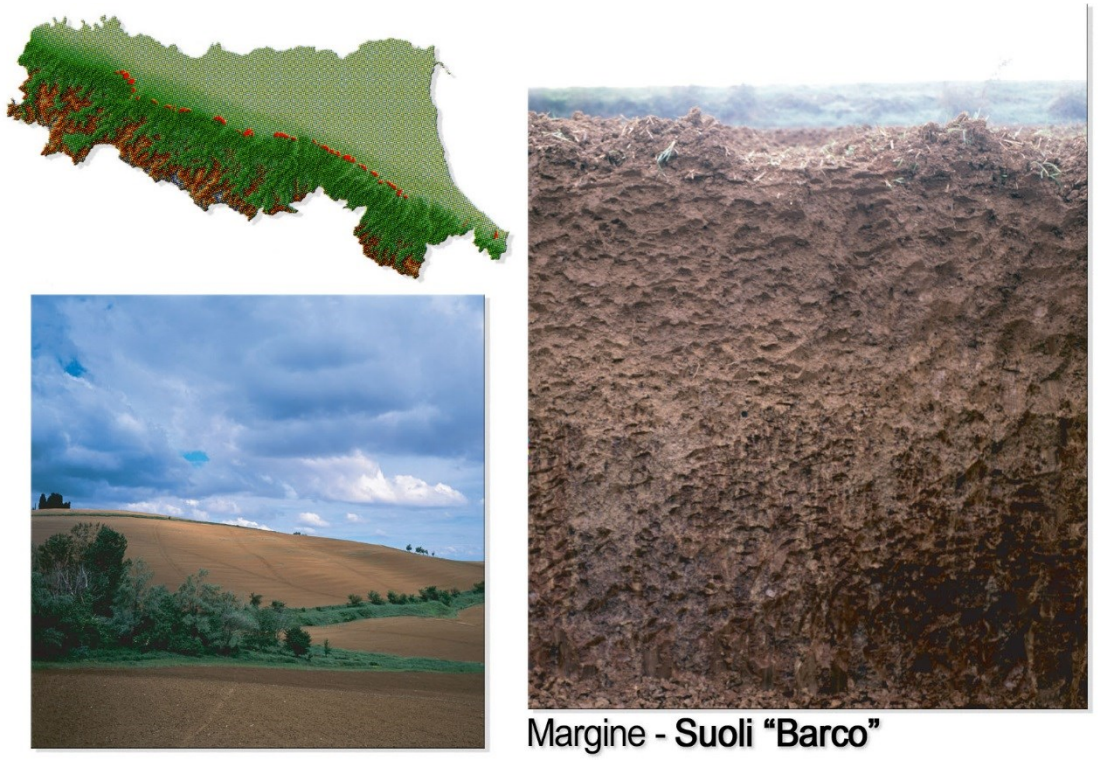


Figure 9. Apennine margin: area, landscape and profile of a representative soil.

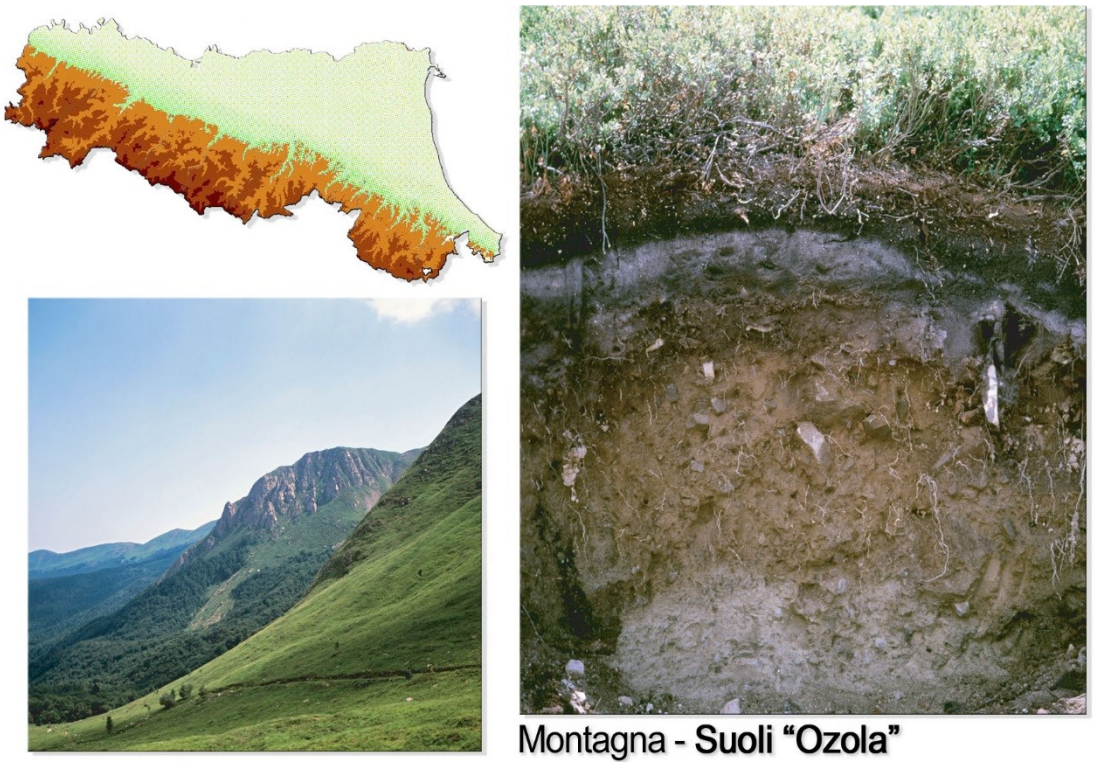


Figure 10. High Apennine: area, landscape and profile of a representative soil.

2. Soil characterization

In order to reuse the soil produced from the excavation of a building or infrastructural work, whether public or private, it is necessary to define its legal nature: it can be considered "non-waste" (Legislative Decree 152/06, Article 185 paragraph 1, letter c) bis) or "by-product" (art.186 Legislative Decree 152/06 and Presidential Decree 120/17). This bivalent nature implies two different management possibilities since in the first case soil can be reused only in the site where it was produced, while in the latter it can be moved to other sites.
In both cases soil must be characterized from an environmental point of view with chemical analyzes that assess its non-contamination (leaching test and determination of the content in mg/kg dm of the contaminants listed in Annex 5 to Part V, Table 1, column A of Legislative Decree 152/06) to be carried out in specific ways.
These Guidelines want to associate to the characterization already provided by compliance with the above regulations, a qualitative/agronomic characterization to improve its reuse in urban or peri-urban areas. As outlined in Figure 11, not all uses in urban areas require high quality soils and at the same time the use of healthy and fertile soils in valuable green areas would allow the creation of a new in situ soil that in time would return to provide, wholly or partially, its ecosystem services.

It becomes necessary then to describe, in the present guidelines, the methods of soil characterization in two distinct areas. The first, which can be defined as "*environmental*", regulates the management, the temporary storage and the intended use of the site of destination of the soils according to environmental regulations, and the second, which can be defined as "*intrinsic quality*" which, once defined the first, intervenes with a greater degree of detail in management.

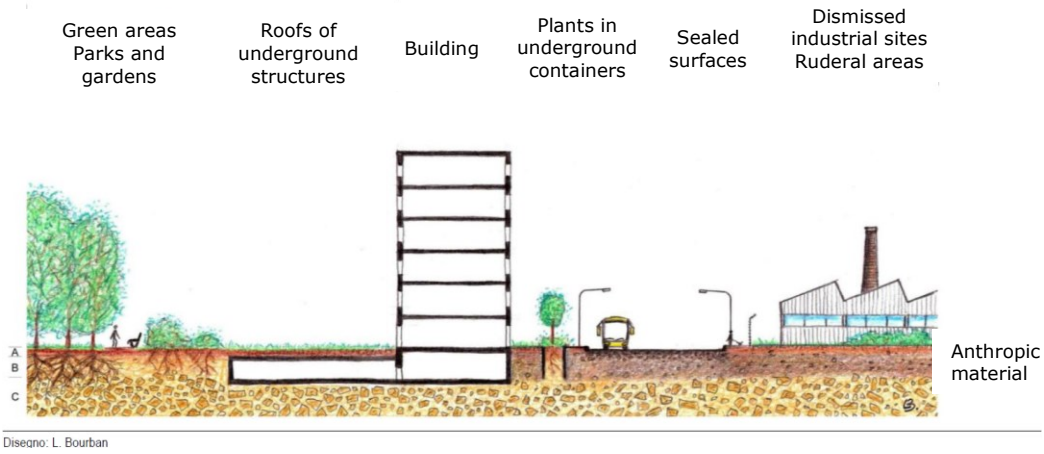


Figure 11. Depiction of various typical situations in urban areas with very variable soil profiles and types.

2.1 Characterization with respect to the environmental requirements according to the law

The legislation context of the norms regulating the use of excavated soils and rocks (hereafter ESR) is outlined by the regulations set by the Parliament and Council of the UE (Dir. 2008/98/ CE, as modified by DIR 2018/851/UE) incorporated into Italian law by the Legislative Decree 152/2006 and the Presidential Decree 120/2017.
The starting point in the Italian legislation is to distinguish whether the soil is to be considered as excavated soils and rocks (hereafter ESR) or as a waste. To this aim, we adopt the definition of by-product given in the Legislative Decree 152/06 *Regulations on environmental matters* at c. 1 of the art. 184 *bis*:

"*It is a by-product and not a waste in compliance with Article 183, paragraph 1, letter a), any substance or object that meets all the following conditions:*

- *the substance or object originates from a production process, of which it represents an integral part and whose primary purpose is not the production of that substance or object;*
- *it is certain that the substance or object will be used, during the same or a subsequent production or use process, by the manufacturer or third parties;*
- *the substance or object can be used directly without any further treatment other than ordinary industrial practice;*
- *any further use is legal, i.e. the substance or object satisfies, for the specific use, all relevant requirements concerning products and the protection of health and environment, and will not lead to overall negative impacts on the environment or human health.*"

and, more specifically, as for ESR, what is reported in Presidential Decree 120/2017 *Reorganization and simplification of the discipline on the management of excavated soils and rocks* in paragraph 2 of the art. 4:

"*[...] the excavated soils and rocks are qualified as by-products if they meet the following requirements:*

a) they are generated during the construction of a work, of which they are an integral part and whose primary purpose is not the production of such material;

b) their use is in compliance with the provisions of the utilization plan referred to in Article 9 or the declaration referred to in Article 21, and is implemented:

1) during the execution of the same work in which it was generated or of a different work, for the realization of reinterries, fills, remodels, mounds, land or road improvements, environmental recoveries or other forms of environmental restorations and improvements;

2) in production processes, in substitution of quarry materials;

c) they are suitable to be used directly, i.e. without any further treatment other than ordinary industrial practice;

d) they meet the environmental quality requirements expressly provided for in Chapter II or Chapter III or Chapter IV of this Regulation, for the specific conditions of use referred to in point (b). "

The DPR 120/2017 presents several cases for which fulfilments, conditions and prescriptions established therein vary with the complexity of the soil production sites. Keeping in mind the distinction between large and small construction sites, depending on whether the excavated volume is, respectively, higher or lower than 6,000 cubic meters, such cases are mainly three: large sites subject to EIA[2] and/or IPPC/IED[3] procedures (in short, LS with EIA/ IPPC/IED), large sites not subject to EIA and/or IPPC/IED (LS) and small sites (SS).

To these cases, two more are to be added: that of soils reused in the production site itself excluded from the waste regulation[4], and that of soils from sites subject to reclamation.

Regarding the fulfillment of environmental criteria, depending on the aforementioned cases, producers must demonstrate (for LS or SS) or certify (LS with EIA/ IPPC/IED) soils compliance with contamination threshold concentrations (**CTC**)[5] and, in if exceeded, compliance with the natural background value resulting from existing official documentation or prior *ad hoc* surveys. In Emilia-Romagna at the URL https://datacatalog.regione.emilia-romagna.it/catalogCTA is available the regional cartography of the natural background value of chromium, nickel, lead, copper, vanadium, zinc which constitutes the regional scale reference to be used to support the investigation plan.

Cases generated by compliance with the CTC or the natural background value are shown in Figure 12.

[2] *Environmental Impact Assessment (Dir. 2014/52/UE)*

[3] *Integrated Pollution Prevention and Control, Industrial Emission Directive (Dir. 2010/75/UE)*

[4] *In compliance with art. 185, paragraph 1, letter c) bis del D.Lgs.152/06*

[5] *Listed in tab. 1 Annex 5 to Title V of Part IV of Legislative Decree 152/06 (Article 12 of Presidential Decree 120/2017)*

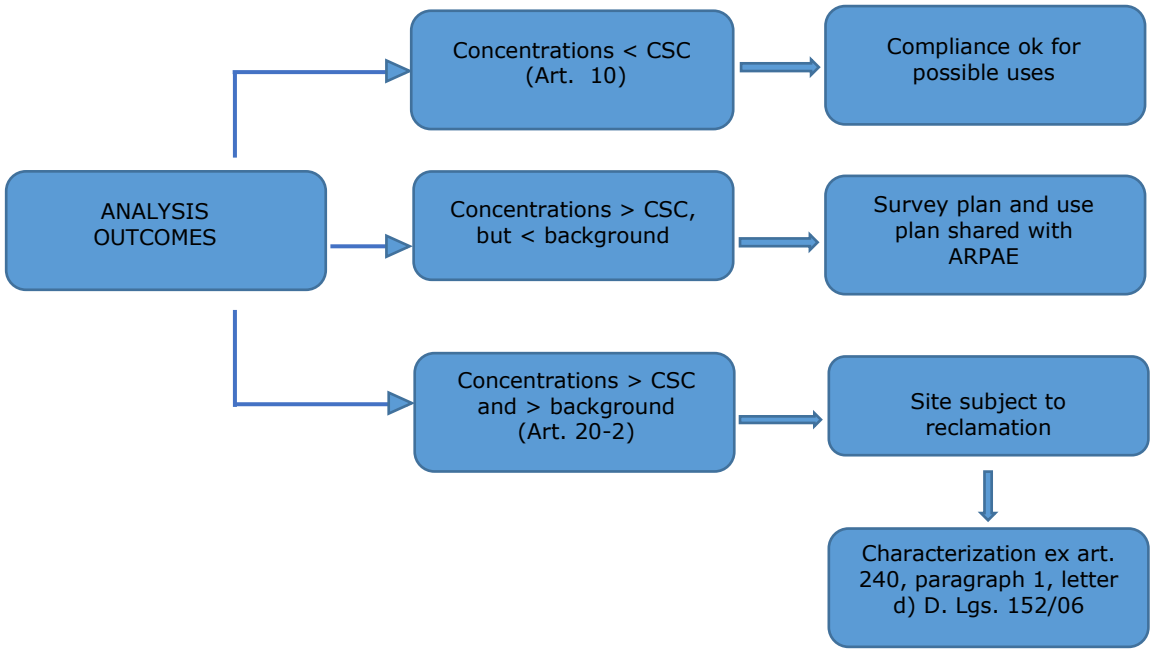


Figure 12. Cases generated by compliance with the CTC or the natural background value.

Once the soils are qualified as a by-product, if the management requirements are not respected, they can "go back" to waste.
For all site typologies, the following tables show the main obligations and the authorities involved in authorizations, communications and control and monitoring activities, listing them line by line according to the administrative and operational procedures that take place over time: presentation of the PU[6], of the declaration pursuant to art. 21 (declaration pursuant to Article 47 of the Presidential Decree 445/00), communication of start of works, controls, and DU[7].

Cases Fulfillments	Large sites EIA/ IPPC/IED	Large sites no EIA/ IPPC/IED	Small sites	Reclamation
Plan of Use presentation Decl. Art. 21	PU (90 days ahead excavation or anyway before EIA/ IPPC/IED)	Communication 15 days before works start		Specific procedures
Qualification	Subst. Certification Art. 47 DPR 445/00			*Transport*: data validation by ARPA for sites of origin and destination *In situ reuse*: Coherent with CTC and CSR
t – Max. duration	From beginning of works LS-EIA/ IPPC/IED up to 2 years (+ exceptional extensions)	LS and SS 1 year + 6 months (+ special extensions)		
Reporting/ presentation	ARPA + Competent authority to issue the final measure	Municipality of production site + ARPA		
D.U.	ARPA, and Municipality of destination site Municipality of production site			

Table 4. Requirements pursuant to Presidential Decree 120/17 for the different site typologies.

[6] *Plan of Use, pursuant to Presidential Decree 120/2017*
[7] *Declaration of use, pursuant to Presidential Decree 120/2017*

	By products	Waste
Qualification	Quality requirement art. 4 par. 2 DPR ESR	17.05.03* 17.05.04
Trasportation	Doc. annex 7	Form
Start fo works	LS EIA/ IPPC/IED: from 90 days to 2 years since presentation or 15 days (others) before works start	-
PU/Decl. Art. 21	YES	NO
Storage	Since works start LS- EIA/ IPPC/IED up to 2 years (+exceptional extensions) LS e SS 1 year + 6 months (+extensions or > duration in special cases) LG-B2.4	Temporary storage in compliance with art. 23
End of works	DU	Disposal/recovery accomplished (4th copy of the form), otherwise Communication AC

Table 5. Requirements pursuant to Presidential Decree 120/17 in terms of the legal nature of the material resulting from the excavation works.

2.1.1 Proposals for improvement of soil management in the application of Presidential Decree 120/17

Given the legislation survey presented in the previous paragraph, we provide some suggestions to improve soil management, in order to maintain as much as possible its quality either environmental or intrinsic with respect to the place of origin, and that could promote a more effective management by the municipalities:

a) differentiate the use of soils based on the content of anthropic materials (bentonite, PVC, fiberglass, etc.) using natural soils, which do not contain such materials, for valuable environmental/urban purposes (such as land improvements, urban parks and residential areas);
b) encourage a flow of information directed to the municipal administrations on excavated soils in order to:
   - follow the whole process (procedural and operational) when in the municipality there are production and/or destination sites and/or intermediate sites;
   - set up a georeferenced database at municipal level on both destination and intermediate sites connected to a dedicated IT platform in order to favor the encounter between soil demand and supply, and recycling in full coherence with the principles of circular economy (see chap .3);
   - extract data at municipal level regarding the identification and size of potentially contaminated sites from the register of the contaminated regional sites. This is advised in order to ensure the completeness of the process under examination, and to favor environmental monitoring and the drafting of reports on soil environmental quality in the municipal area;

c) extend the verification of compliance with the CTCs also for intermediate sites through the preliminary use of the cartographic information available at the regional URL https://datacatalog.regione.emilia-romagna.it/catalogCTA/

2.2 Characterization of soil intrinsic quality for reuse purposes

The characterization of soil intrinsic quality, as well as its environmental quality, takes place before the start of the excavation at the work site.
As can be seen from soil description in Chapter 1 "Definition of soil", the part richest in humus, as well as the one where the nutrients, the micro-organisms and therefore the roots of the plants are more abundant, is the most superficial horizon, also called topsoil (BS3882: 1994, Chapter 3 "Definitions"). Although the soil is a *continuum* from the physical point of view, and all horizons are interrelated through continuous chemical and physical exchanges, it is undoubted that topsoil is the most precious part to reuse, although the entire reuse of the whole excavated soil is desirable.

The fundamental principle is that the more the original characteristics of the topsoil are maintained, the more it is possible to keep its ecosystem services intact, creating the conditions for the formation of a new soil. In some European countries (for example, Switzerland, England, Germany) specific guidelines have been drawn up for soil management that provide for a separate management between the upper layer and the underlying ones. Based on the British Standard N.3882:1994 addressing topsoil quality levels from which *ad hoc* reuses are derived, we adopt the following classification scheme for topsoil quality:

a) *High quality or "Premium" Topsoil*

High quality topsoil is the natural topsoil, where by natural we mean in situ and not artificialized by the presence of backfills. It is a horizon with high intrinsic fertility, loam textured and well structured. If properly managed, it can be used in greenhouses, gardens, horticulture areas, landscape and leisure parks, where it is intended to support the growth of the most demanding plants. In fact, it is suitable also for more intensive crops (for example, annual rotation crops).
This high level of soil quality is not essential in most topsoil applications, where lower quality levels can fully meet the required needs.

Note 1: *remember that the high quality soils are generally those available in smaller amounts and therefore there is a more limited offer.*
Note 2: *if improperly handled or stored, their quality could be reduced and fall into a class of lower quality of topsoil.*

b) *Medium quality Topsoil (General purpose grade)*

Medium quality topsoils include natural topsoils with lower fertility characteristics, texture and structure than those of high quality, high quality topsoils deteriorated due to poor management, as well as artificial ones that maintain good properties. These soils, if properly managed and located on the right sites and under the correct climatic conditions, can be used for good quality agriculture, for forestry, horticulture, for recreational areas, environmental restorations and landscape planning; they can support the cultivation of orchards, meadows, trees, shrubs, grasses forage and other plants or species.

Note: *medium quality topsoils may require an improvement of thier characteristics through a treatment with soil improvers or fertilizers*.

c) *Low quality Topsoil (Economic grade)*

Low quality topsoil includes natural topsoils with lower fertility, texture and structure characteristics compared to the previous category, selected "subsoils" or sediments suitable for plant growth. They are divided into two sub-categories: with low or high amounts of clay. The latter require more accurate management and are less tolerant of compaction.
These materials are suitable for realizing wildlife conservation areas, woods, scarcely visited leisure meadows and low-productivity farmlands.

***Note**: due to the different possible origins of soil materials, a minimum amount of organic matter or nutrients is not specified. In the case, however, of very low quality, then it might be necessary to fertilize, to fertilize and cultivate (sometimes for a certain number of years) the soil to obtain a satisfactory level of productivity. Under these conditions, the soil quality could improveand reach one of the two upper levels of quality.*

For large construction sites (LS), topsoil quality characterization can be obtained from a soil survey: in this case the size of the work is such to support the costs of an *ad hoc* soil survey supported by the analytical data and parameters necessary to define topsoil quality class (Table 6). For small sites (SS), in order not to further increase the costs for ESR manufacturers, we refer to the use of thematic maps derived from the 1: 50,000 soil map, accompanied by the instructions for use.

In the following chapter 5, we present a matrix for the definition of topsoil quality classes with the following regional maps: the soil capability map can be used individually as it alone represents the parameters of soil fertility in relation to its physio-chemical characteristics. However, due to the relevance of other parameters needed for the assessment of topsoil quality class, which has not been taken into account in the method used to draw up the soil capability map, other maps have been added to the matrix. These are the map of soil organic matter, the maps of the content of nitrogen, phosphorus and potassium, and the soil texture map.

	High quality	Medium quality	Low quality	Analytical method
Textural class	SiCL (clay ≤ 27%), CL, SL, SCL, SiL, L	LS, SL, L, SiL, SC, CL, SiCL (clay ≤ 35%), SiC, C (silt MAX 50%)	LS, SL, L, SiL, SC, CL, SiCL (>35%), SiC, C (silt MAX 50%)	D.M. 13/09/1999
Nutrients content **N** (g/kg) **P_2O_5** (mg/kg) **K_2O** (mg/kg)	N >0,5% P_2O_5 >23 ppm K_2O > 120 ppm	N >0,5% P_2O_5 >23 ppm K_2O > 120 ppm	nd	D.M. 13/09/1999
Organic matter (CO*1,726)	≥ 2,5%	≥ 2%	< 2%	D.M. 13/09/1999

Table 6. Topsoil parameters requirements for quality classes and reference analytical methods.

The minimum requirements of the pedological report are listed in Annex 1.

3. Soil supply and demand exchange and de-sealing

To make the reuse of soils easier, it is effective to use a public IT platform that connects the producers of soil to the areas subject to de-sealing through a list of areas ready to receive soils. This would create a sort of ad hoc IT market that fosters the meeting between soil supply and demand, from which the producer can choose the optimal destination site, once the quality of the excavated soils has been established[8].

The practice is already growing in this sense, albeit in a generic way, on all the materials resulting from excavations, therefore also sediments: a policy of exchange between supply and demand has already been structured at a national regulatory level, through setting up the first operational instruments.
At the regional level, in Emilia-Romagna, the reuse of soil is implicitly incentivized through the regeneration actions which the new urban law refers to. Moreover, we observed some voluntary initiatives by the Municipalities for the reuse of excavated soils (e.g. in Misano Adriatico for beach nourishment and in Forlì for the identification of regeneration sites).

On a **national scale**, a by-product platform has been set up, currently operating (based on the Ministerial Decree of the Ministry of the Environment and Protection of the Territory and the Sea, MATTM, 264/2016) and managed in a unitary manner by Unioncamere (https://www.elencosottoprodotti.it/). It contains a unique database of producers and users of excavated soils. The registration by the companies is voluntary and the quality of the soils must comply with the prescriptions of the current legislation, although the registration to the platform is not sufficient to verify these requirements (Circular of the MATTM n.7619 / 2017).
This national initiative is obviously an excellent incentive to activate reuse, but the national scale of the exchange between demand and supply involves the risk of a high environmental impact. Moreover, the whole process is not easily monitored in its results since the list is currently accessible only to registered companies, although the decree states that access should be free (Figures 13 and 14). The geo-referencing of the excavation and de-sealing sites would make the research more direct and effective.
At present, from the experiences of the authors of this text, it is noted that the offer of sites where to receive the excavated soils, is less extensive than the soil made available, representing then a gap between supply and demand.

[8] *Local experiments and experiences are taking place internationally and in other Italian regions. As a non-exhaustive, internationally, the metropolitan city government of New York City (Mayor's Office of Environmental Remediation) has activated a database of urban soils (http://www.nyc.gov/html /oer/html/nyc-clean-soil-bank/nyc-clean-soil-bank.shtml visited September 18, 2018).*
In Stuttgart, the 1: 20,000 soil map (Stuttgarter Bodenatlas) is an integral part of urban planning (BOKS - Bodenschutzkonzept Stuttgart - Schriftenreihe des Amtes für Umwelschutz - Heft 4/2006). A similar approach has also been implemented by the Senatsverwaltung für Stadtentwicklung und Wohnen of Berlin (Planungshinweise zum Bodenschutz, Ausgabe 2015).
In Veneto, however, already in 2010 a site for the exchange of soils was created and is still operative, managed voluntarily by producers and possible users: www.terredascavo.it.

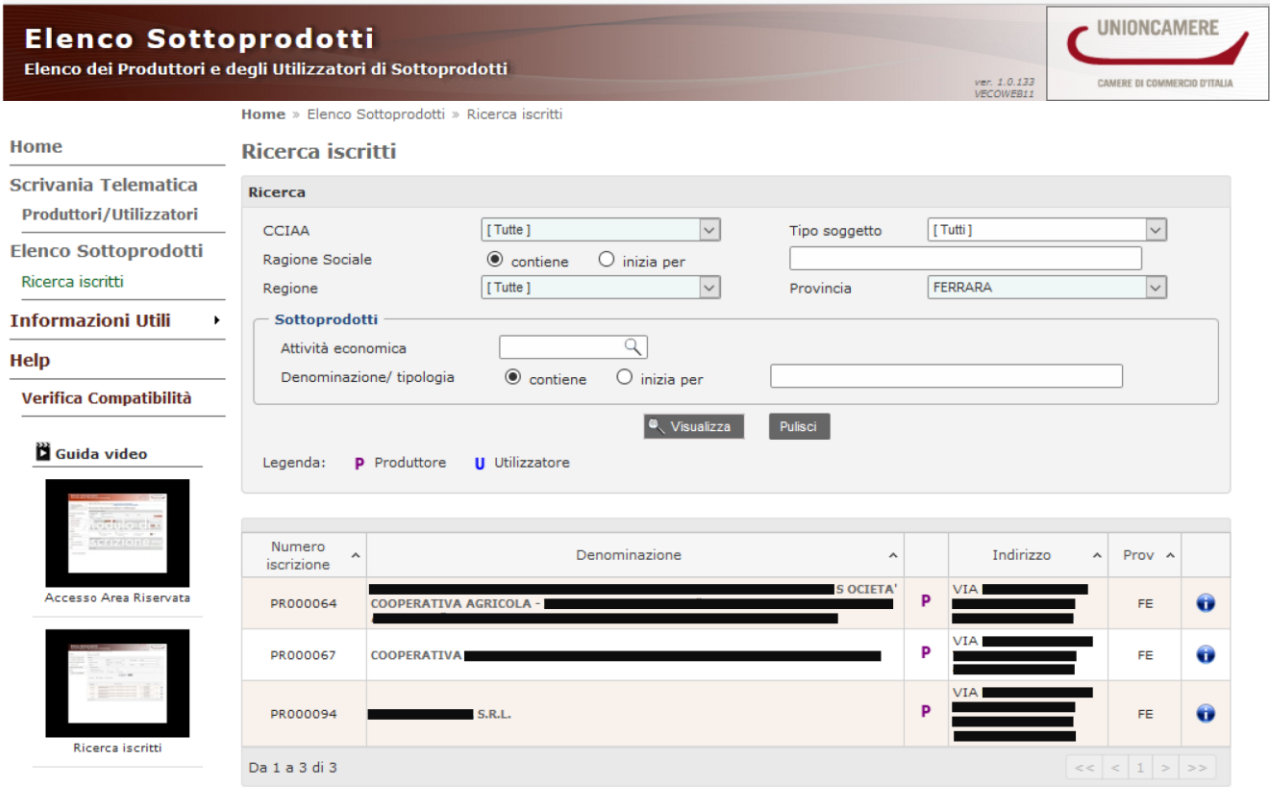


Fig. 13. Screenshot from the National Portal "Elenco sottoprototti" (By-products list) by Unioncamere (as from February 18th 2018).

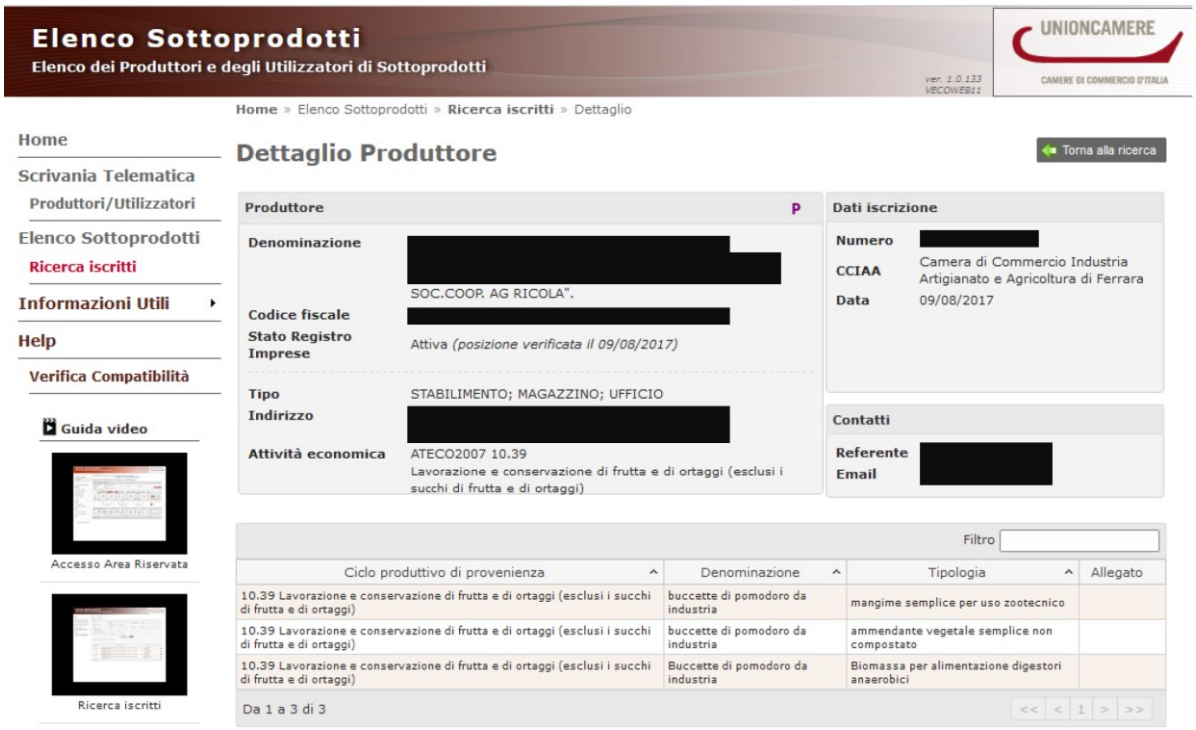


Fig. 14. Screenshot of the information for a producer in the National Portal "Elenco sottoprototti" (By-products list) by Unioncamere (as from February 18th 2018).

On a **regional scale**, in Emilia-Romagna, the recent regional planning law (LR 24/2017) encourages urban regeneration and the limitation of land take, favoring, *inter alia*, de-sealing with the possibility of breaking down the value of works from the construction cost in the case of production interventions (Article 6, paragraph 6), and providing that the Municipalities prepare a list of public and private buildings made available for reuse and urban regeneration (art.15).
The Regional Resolution 1216/2018[9], moreover, allows the Municipalities to identify further reductions in the construction cost in the interventions of urban regeneration[10], thus leaving the field open to the choice of criteria for deductions that could encourage soil reuse.
Furthermore, some municipal actions, prior to the establishment of regional and national regulations, point explicitly in the direction of soil reuse. The Building Regulations of Misano Adriatico (Rimini) since 2001, commits individuals[11] to allocate to the municipal administration any sand or gravel materials obtained from excavation work; the first to be used for beach nourishment, and the latter for public works.
In light of these elements, it is proposed to integrate the register of properties made available for urban regeneration (Article 15 LR 24/2017) that the Municipalities (or Unions of Municipalities) in Emilia-Romagna have to prepare according to the new urban planning legislation, with a list of de-sealing areas ready to receive soils, to be made available to soil producers. These will be then able to choose the destination sites based on the specific characteristics of soils produced as part of the excavation operations.

[9] *GPG/2018/1216 of 11/07/2018: "Regulation of the construction fee pursuant to Title III of the Regional Law 30 July 2013, No. 15 in implementation of Articles 16 and 19 of the D.P.R. June 6, 2001, n. 380 "*
[10] *DGR 1216/2018, Point 4. "In implementation of the regional urban planning law, within the urbanized territory, the construction fee is reduced by no less than 35% for urban renewal and building renovation, densification or urban substitution, and for the recovery or reuse of abandoned or discontinued properties. For the same interventions, the Municipalities have the right to deliberate further reductions, up to the complete exemption from the fee".*
[11] *Annex A to the Building Regulations, approved by Municipal Deliberation n. 67/2001.*

4. Soil management on construction sites

General principles:

- Rather than restoring soils that have not been correctly managed, preventing their degradation is easier and cheaper.
- Reduce to a minimum the areas occupied and soil removal for the realization of the project (worksite tracks, plants, soil removal works on excavated or worked surfaces).
- Valorize the upper layer removed (and possibly the lower as well). By valorization, we intend the re-use of removed soil according to its quality, whether on site, or off-site.

Goals:

- Preserve soil fertility.
- Preserve the integrity of soil aggregates after each soil occupation or removal.
- Preserve soil pores, in terms of their diversity and continuity.
- Preserve the thickness and the order of soil horizons.
- Ensure the valorisation of the removed soil even outside the construction site on the basis of its quality.

4.1 Soil management on production site

Management begins with the characterization phase, which in turn depends on the size of the site (small construction sites do not need a specific soil survey, which is essential for large construction sites).
It is up to the technicians responsible to adapt these general requirements to the context, to specify the measures according to the type of project, and to adjust the degree of detail to the planning phase (technical and economic feasibility project, final design, and executive project).
A soil protection strategy will include the following elements:

- the description of the initial state;
- the timetable for the works and restoration objectives;
- minimization of occupied areas and measures to reduce soil removal;
- the preliminary grassing of occupied areas;
- the choice of machines and soil removal method;
- accesses, runways and open spaces for temporary construction equipment;
- temporary deposit and balance of removed materials (upper and lower layer);
- soil restoration at the end of the works (removed and not removed soil);
- re-planting of a vegetation cover and supervision by completion of the works.

As a general principle, it is recommended to prefer, when conditions are met, the reuse of excavated soil within the same area.

Preliminary phase

This phase encompasses four main actions:

- characterization according to Presidential Decree 120/2017 (Article 4 and Attachments 2 and 4);
- identification of the current land use (photographic reports and GoogleEarth images) and any restrictions on the site (resulting from the consultation of the regional portal minERva);
- determination of soil intrinsic quality of the soil through the regional cartography available on the portal minERva, using the assessment matrix contained in this guidelines (chapter 5);
- choice of the destination site based on soil intrinsic quality and, first of all, on the basis of the list of disused areas available for urban regeneration (Law 24/2017 art.15).

Construction site phase

Soil management, prior to its re-use, requires the application of the following:

- edition of reports for the management of the soil resource: layout of the areas of intervention and deposit, the depth of the topsoil/subsoil to be removed, the building site used, the height of the piles, the grassing, the moisture measurements;
- for large construction sites the report will be part of the land management plan and will be appropriately connected to the works schedule; for small sites it can be made up of a layout with an indication of the different areas;
- reporting to the Director of Works and to the contractors of the Land Management Plan, indicating all the operating procedures envisaged for soil management.
- verify that all employees, and in particular machine operators, are equipped with a soil management plan; verify that the operations already carried out in the plan are indicated in an *ad hoc* document. If necessary, for the good site management, organize a training of the operators. All operators must be informed in advance about good practices not only for personal safety purposes, but also for environmental protection purposes;
- daily assessment of soil moisture, adapting the work program accordingly. Measurements should be made with tensiometers (Figure 15). In the case of particularly heavy rainfall it is necessary to suspend soil removal for at least one day without precipitation and, in any case, until the level of soil moisture has fallen within the set humidity criteria.

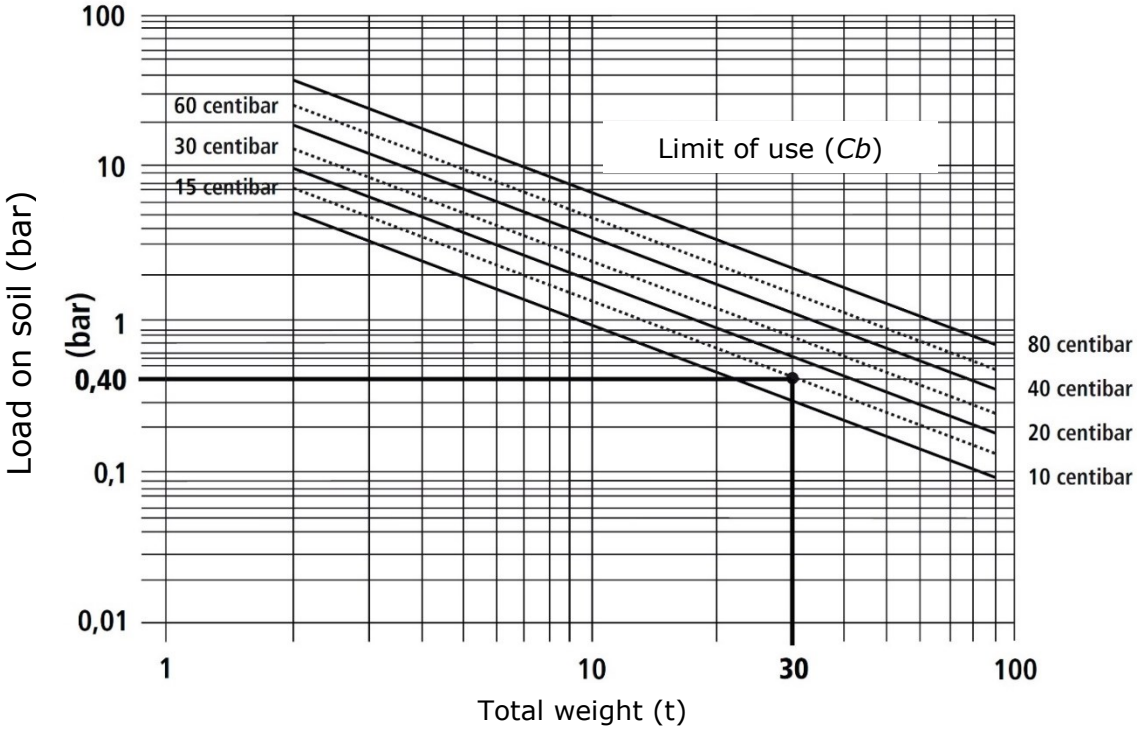
Figura 15. Soil moisture measurement with quick response tensiometer (Source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015 - J.P. Clément).

The limit of use (*Cb*) of the crawler machine on construction site, expressed in terms of minimum capillary tension allowed in the soil (in centibars), can be determined with the following formula:

Cb = total weight of the machine [t] x load on soil [bar] x 1,25

From the nomogram shown in figure 16 it is possible to directly deduce the minimum required capillary tension.

Example: a machine of 30 t of weight given a load of 0.4 bar can be used without any particular protection measures starting from a capillary tension of 15 Cb.



Limit of use (*Cb*) =total weight (t) x load on soil (bar) x 1.25

Example	**Total weight**	**30 tons**
	Load on soil	**0.4 bar**
	Limit of use	**15 centibar**

Figure 16. Nomogram for the limit of use of machinery at construction sites (source: Costruire proteggendo il suolo. Guida all'ambiente n. 10. Ufficio federale dell'ambiente, delle foreste e del paesaggio, UFAFP, 2001)

The limit of tolerance for the use of light wheeled vehicles requires capillary tensions >25 Cb, and can also be divided into the following categories according to the wheel load:

> 3.5 t	load on the wheel:	**harmful to soil**;
2.5 - 3.5 t	load on the wheel:	**critical for soil**;
< 2.5 t	load on the wheel:	**tolerable for soil**, provided that: - capillary tension is > 25 *Cb* and - pressure at contact surface < 0,5 *bar*.

It is preferable to use proper machinery and handling techniques, with the correct evaluation of weight, pressure distribution and operation range of machines; the use of crawler vehicles should be preferred. Soil protection experts agree that the best solution to avoid soil deterioration is a crawler hydraulic excavator equipped with a bucket with a smooth edge. Ideally, the weight of the excavator should be less than 25 t and results in pressure on soil surface less than 0.5 kg/cm².

Figure 17. Crawler hydraulic excavator equipped with bucket (source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015 - R. Quartier)

It is recommended to:

- suspend work in the case of rain.
- Remove the soil only in the area to be built, and do not remove the soil under the deposits, the tracks and the site installation areas.
- Perform soil removal in strips and separately for the A and B horizons, avoiding transiting on both.
- Remove the soil with the excavator, realizing, where necessary, suitable handling tracks; these worksite tracks allow to distribute loads and reduce soil compaction. It should be noted that the creation of these temporary features can only start when the soils are dry enough.
- Storage in heaps at dedicated storage areas on the production site.
- Identify the heaps with appropriate signs, indicating the type, quantity and indication of possible reuse.
- Avoid the transit of construction machinery on the deposited material. In particular, the excavator must not climb on temporary soil deposits to build a slope or to move them.
- Manage the heaps of excavated soils in order to avoid leaching, dragging of solid material by rainwater and dispersion of dust into the air, for example with cover or grassing and drainage of the storage areas.
- Realize the storage of excavated soil in such a way as to avoid dispersion of materials in areas not under construction and in channels that are part of the storm water drainage system.
- Store topsoil in heaps no higher than 2 m, to preserve its physical, chemical and biological characteristics so as to be able to then reuse it in the environmental recovery works of the area after the dismantling of the construction site; for storage time over 2 years, we recommend the grassing of the heaps.

- Absolutely avoid deposits in troughs to reduce the risk of water stagnation and anoxia that could occur in the event of heavy rains. In case of overland flow along the slope, rainwater must be able to flow down; in this case, drainage must be provided.
- Provide grassing according to the duration of storage, the type of soil removed and the presence of unwanted vegetation.
- Take into account, as part of the planning and implementation of the work, the maintenance of temporary deposits (mowing, weeding).
- Use non-woven geotextile under temporary deposits that must last at least one winter.
- Means of transport and operating machines must use only the site traffic network indicated in the project, absolutely avoiding all soil storage areas.

	***Track with excavation material coming directly from the construction site*** *The excavated material is not always suitable for the creation of proper worksite tracks.* *The coarser the grain size, the worse is the load distribution. It is necessary to avoid materials with a diameter > 15 cm.*
	***Interlocking movable slabs*** *The slabs must overlap enough to guarantee track resistance and soil protection. They must be fixed by pins. The advantage in their use lies in the lightness and ease of transport.* *In addition to creating temporary runways, this procedure is particularly suitable for removal works on soft soils (e.g. organic soil).*
	***Roundwood mattresses****:* *This efficient and economical method is suitable for short-term or punctual soil removal.* *However, experience has shown that in case of frequent transit, the roundwood could be rapidly weakened.*

Figure 18. Example of soil stripes removal from a temporary construction track (source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015 - disegno L. Bourban)

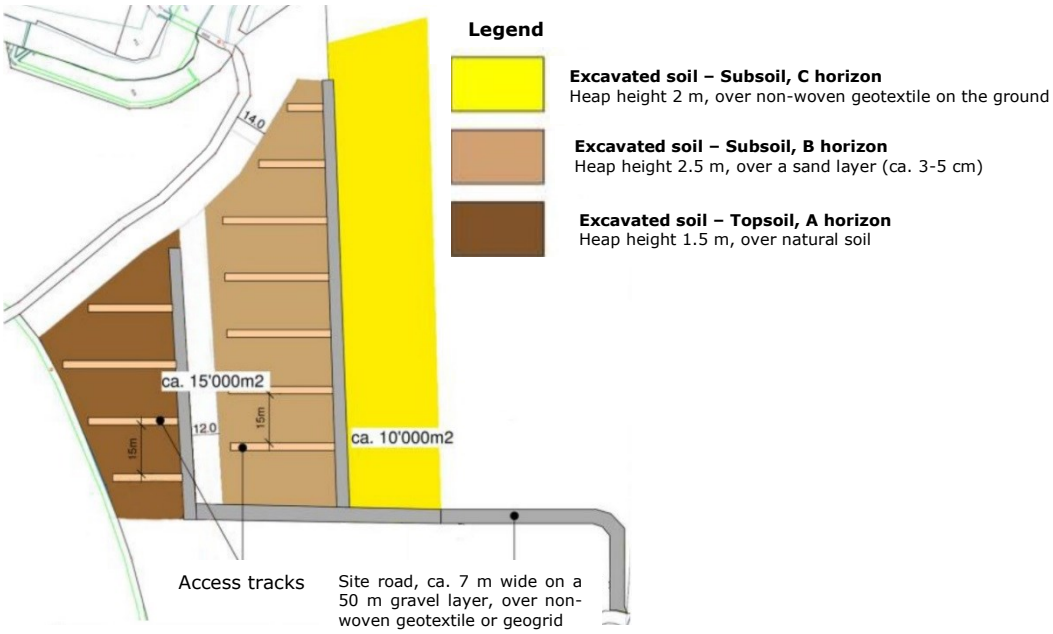


Figure 19. Example of a plan of soil storage areas (source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015, mod.)

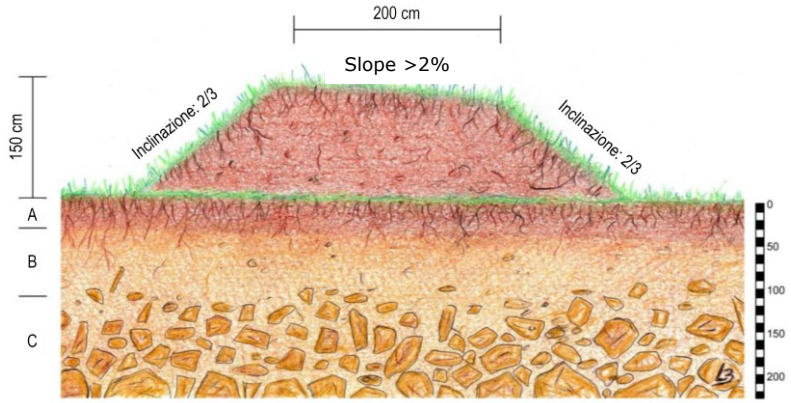


Figure 20. Example of temporary storage of removed topsoil; duration over 1 year (source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015 - disegno L. Bourban).

Recommended dimensions for temporary storage according to soil type of and duration of storage (the height of the deposit always refers to loose material)**:**

Topsoil (A horizon)	**Temporary storage** (winter excluded)	**Temporary storage** (during winter)
Grassing necessary?	**YES**, if duration > 5 months Warning: fast growth of weeds could occur. If this case, rapid sowing recommended.	**YES**
Heap height according to clay content and soil sensitivity	**1,5** m; **1** m if clay >30%	**1,5** m; **1** m if clay >30%
Subsoil (B horizon)	**Temporary storage** (winter excluded)	**Temporary storage** (during winter)
Grassing necessary?	**YES**, if duration > 5 months In case of weeds, sow promptly.	**YES**
Heap height according to clay content and soil sensitivity	**2,5** m; **2** m if clay >30%	**2,5** m; **2** m if clay >30%

For all the specifics concerning soil storages management, however, please refer to the D.P.R. n. 120/2017.

Soil management at the intermediate storage site

As an alternative to on-site reuse, it is possible to store the soil at an intermediate site (Figs. 20 and 21), waiting for another site to be available for re-use.
In soil management, pending re-use, also in the case of an intermediate storage site, the following procedures are to be applied:

- Prepare an intermediate storage site management plan that identifies storage areas, storage methods, the height of topsoil/subsoil heaps to be stored and the conditions for grassing and humidity control.
- Storage in heaps at the dedicated storage areas, identifying the heaps, separated for horizons A and B, with appropriate signs, indicating type, quantity, origin, possible destination of use and the date of arrival at the site.
- Implement temporary storage on a non-woven geotextile that must last at least one winter.
- Manage the heaps of excavated soils in order to avoid leaching, removal of solid material by rainwater and dispersion of powders in the air, for example with cover or grassing and setting up an adequate drainage system.
- Store the soil in such a way as to avoid dispersal in areas not identified for storage and in the channels that are part of the storm water drainage system.
- Absolutely avoid deposits in troughs to reduce the risk of stagnation and anoxia that could occur in case of heavy rains. In case of overland flow along the slope, rainwater must be able to flow; in this case, drainage must be provided.
- Store topsoil in heaps no higher than 2 m in height, to preserve its physical, chemical and biological characteristics in order to reuse it in environmental recovery works at areas identified for de-sealing operations; for storages over 2 years, grassing is recommended.
- Means of transport and operating machines must use only the site traffic network indicated in the project, absolutely avoiding all soil storage areas.

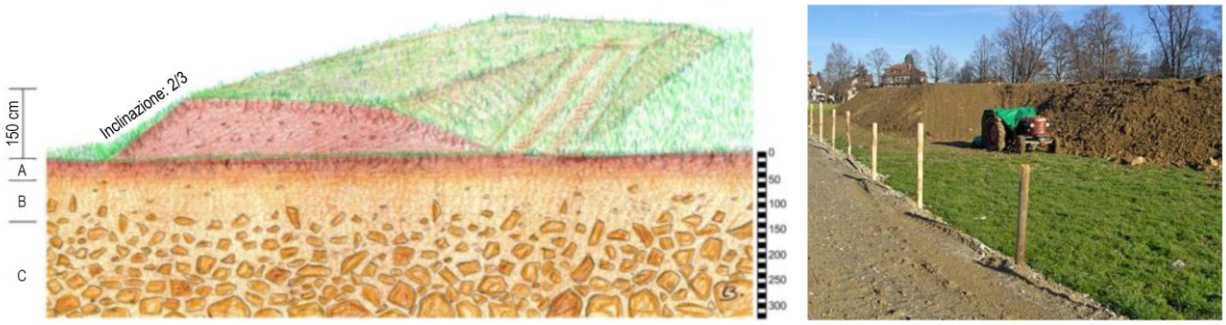


Figure 21. Example of a long-term temporary storage (source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015 - disegno L. Bourban – foto R. Quartier)

Soil management at destination site

At the end of the works the direction of the works sets up soil restoration or soil backfilling on temporarily occupied areas.
Soil restoration, as well as the "*transitory recultivation phase*", must be carefully planned.
Before proceeding with the placement of the soil, it is necessary to make sure that the receiving subsoil is loosened, working it when dry. Also ensure that the receiving area is adequately drained; the continuity of the hydraulic conductivity at the base of the restored soil must always be guaranteed.
The criteria established in the context of soil restoration depend on the objectives of use after completion of the works. The pedological characteristics of the soil material affect its utilization according to the intended use (e.g. green space, productive agricultural land, productive forest, land used extensively).
Once the subsoil surface has been prepared, it is advisable to correctly reconstruct the soil layers' sequence, starting from the restoration of lowest horizon (subsoil, B horizon and A horizon) up to the required thickness, and avoiding the movement of heavy machinery on the freshly layered soil. These operations must also be carried out only in dry soil conditions.
It is recommended to put the lower and upper layers back in place by means of a crawler excavator in a single operation, in sequential strips and in the direction of the slope. Transit of machinery is forbidden on the restored soil.
Proceeding in sequential strips has the advantage of:

- allow a net gain of time, since this procedure is more efficient and less vulnerable to weather conditions;
- avoid the passage of machines on the lower layer and on the restored soil;
- avoid the obligation to temporarily grassing the lower layer.

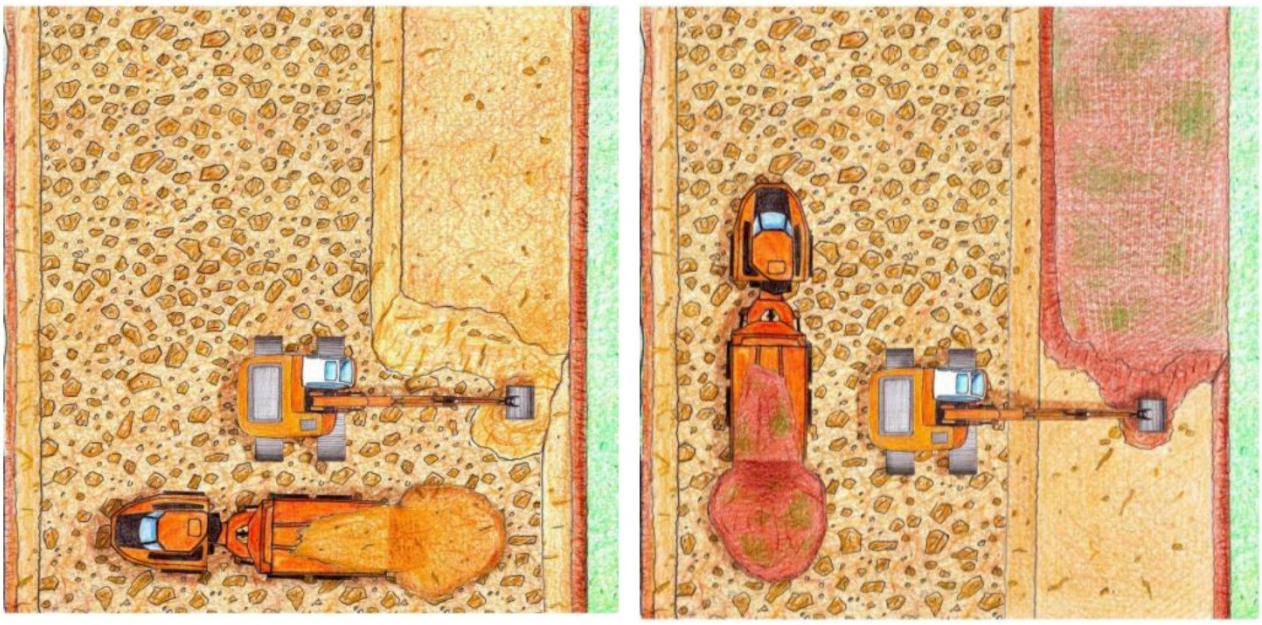


Figure 22. Example of stripe emplacement of lower and upper soil layers (source: Suolo e cantieri. Stato della tecnica e della prassi UFAM 2015 - disegni L. Bourban)

Once all the operatiosn have been completed, it is advisable to cultivate the superficial soil by removing any stone and planting immediately.
Do not use the horizon B as a filling material.

5. Definition of topsoil intrinsic quality classes based on available cartography and possible reuse

This paragraph aims to provide a small guide, based on experience in this field from other European countries and on the cartographic and pedological information available in the Emilia-Romagna web sites, in order to reuse adequately the topsoil in landscape and environmental interventions.
The following tables link the soil qualities (in particular of the topsoil) with its possible agricultural or landscape-environmental reuses. In particular, the reuses are based on the following soil parameters: classes of soil capability, organic matter content, nutrients status (nitrogen, phosphorus and potassium, NPK) and soil texture. The available mapped information covers the entire plain and does not include, however, the hilly areas. In the forthcoming years, however, the maps, and in particular the soil capability map, will be extended to the mountain part of the region; the links of the Emilia-Romagna regional cartography are listed in the “parameter” column.

***Note 1**: the Soil Capability Map, in order to define soil capability classes, uses both chemical parameters related to fertility (excluding the organic carbon content), and physical parameters linked to soil drainage and workability. As such, it can also be used as the only comprehensive tool for assessing soil intrinsic quality. The other suggested maps represent and measure, on the other hand, individual relevant parameters. The choice of the cartography to use is left to the single user and, presumably, will vary according to the purpose of the reuse. The types of reuse are always the same for the same quality class; in the case of agricultural or naturalistic reuse, it is more appropriate to use the parameters of soil fertility or capability as a reference, while for engineering works it is more useful to pay attention to the soil texture. In general, the principle to be pursued is that according to which only low quality soils are to be reused for purely engineering works, while the soil with higher quality must be reused primarily for naturalistic and landscape works.*
The types of reuse used in the tables, especially for engineering works, serve as examples and orientation and do not intend to be exhaustive on the topic.
***Note 2**: the topsoil for reuse must be in accordance with the law for environmental parameters (DPR120 / 17) and not contain material of anthropic origin.*
***Note 3:** urban green areas are the areas within the perimeter of the urbanized territory as defined by art. 32 of the Regional Law of Emilia-Romagna 24/17 "Regional regulation on the protection and use of the territory", which includes:*

a) *densely built areas with prevalent residential, productive, commercial, management and service destination, tourist accommodation, infrastructures, public facilities and services however named, urban parks as well as lots and unbuilt spaces equipped with infrastructure for settlements urbanization;*
b) *lots for which building permits have been issued or submitted for new buildings or the implementation of urban planning agreements;*
c) *individual building lots identified by the plan in force at the date of entry into force of this law and located within densely built areas or next to them;*
d) *building lots, equipped with infrastructures for the urbanization of the settlements as they are part of an implementation urban plan, however called, implemented or being completed.*

The following are not part of the urbanized territory:

a) *rural areas, including those inter-locked among several urbanized areas also having a high settlement contiguity;*
b) *scattered or discontinuous buildings, located along the road network and the respective territories and completion areas;*
c) *non-sealed areas located within the densely built areas that do not have infrastructures for the urbanization of settlements;*
d) *areas of relevance for mobility infrastructures, located outside the densely built areas.*

PARAMETERS	MAP UNIT CLASS	INTRINSIC QUALITY CLASS	REUSE IN GREEN URBAN AREAS	REUSE IN GREEN PERI-URBAN, EXTRA-URBAN AND RURAL AREAS
Soil Capability Map The "Soil Capability Map for Agriculture and Forestry" is a document to evaluate the capacity of soil to sustain crop and forest growth under normal conditions for long periods, without the occurrence of soil degradation phenomena. Its reference basis is the scheme of the U.S.D.A Land Capability Classification (U.S., Klingebiel and Montgomery, 1961). https://datacatalog.regione.emilia-romagna.it/catalogCTA/ (portale minERva)	**I; I/II; I/II/III; I/III; II; II/I; II/I/III; II/III; II/III/IV; II/IV;**	**High**	- vegetable gardens, gardens, nurseries, parks; - urban flowerbeds; - hanging gardens; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes.	- agricultural areas with annual rotation, vegetable gardens, nurseries, gardens, landscape restoration to recreational or natural areas with particularly demanding plant species, or used for agricultural use with annual rotation; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes.
	III; III/I; III/II; III/II/IV; III/II/VI; III/IV;	**Medium**	- vegetable gardens, parks, gardens, sports and recreation areas *; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - water protection zones and collection points; - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - green of industrial and craft areas, also as protection against noise and odors.	- agricultural areas (land improvement), gardens, forestry, horticulture, landscape restoration with grasslands, cultivated fields, trees, shrubs*; - recreation areas*; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - water protection zones and collection points.
	IV; IV/III; IV/II; IV/VI; V; V/II; VI/IV; VIII	**Low**	- parks with lawns, lawns for underground facilities coverings, buried plant containers, roundabouts, traffic islands; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***	- restoration of quarries used as recreational or natural areas (wildlife shelter); non-productive grasslands, agricultural areas with low productivity *; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***

* To manage with proper conservation practices
** Clay <30%
*** Dry swale are realized over well-drained permeable soils, wet swale over poorly drained soils; rain gardens are essentially small wet swales

PARAMETERS	MAP UNIT CLASS	INTRINSIC QUALITY CLASS	REUSE IN GREEN URBAN AREAS	REUSE IN GREEN PERI-URBAN, EXTRA-URBAN AND RURAL AREAS
Soil organic matter (SOM) content map. **NOTE:** SOIL ORGANIC MATTER (SOM) IS NOT EXPLICITLY TAKEN INTO ACCOUNT BY THE SOIL CAPABILITY CLASSIFICATION SCHEME AND MAP AS IT CONSIDERS SOIL FERTILITY LINKED TO CATIONS EXCHANGE CAPACITY AND EXCHANGEABLE Na. THEREFORE THE TWO MAPS CAN BE IN CONTRAST BETWEEN THEM. THE SOM MAP MUST BE USED IN ASSOCIATION WITH THE MAP OF SOIL TEXTURE AND IN THE ALTERNATIVE TO THE SOIL CAPABILITY MAP **0-30 cm.** [*] According to the evaluation scheme of D.P.I. RER 2015 The SOM map describes qualitatively the content of organic matter in the first 30 cm of soil according to the assessment scheme contained in the Integrated Production Regulations (D.P.I. 2015) of the Emilia-Romagna Region. This information is useful to apply more rational and sustainable agricultural techniques in order to obtain products of guaranteed quality, respecting the environment and human health. https://datacatalog.regione.emilia-romagna.it/catalogCTA/ (portale minERva)	**High** *Max. quantity of soil improvers required per year 9/ton/ha*	**High**	- vegetable gardens, gardens, nurseries, parks; - urban flowerbeds; - hanging gardens; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes.	- agricultural areas with annual rotation, vegetable gardens, nurseries, gardens, landscape restoration to recreational or natural areas with particularly demanding plant species, or used for agricultural use with annual rotation; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes.
	Medium *Max. quantity of soil improvers required per year 11/ton/ha*	**Medium**	- vegetable gardens, parks, gardens, sports and recreation areas *; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - water protection zones and collection points; - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - green of industrial and craft areas, also as protection against noise and odors.	- agricultural areas (land improvement), gardens, forestry, horticulture, landscape restoration with grasslands, cultivated fields, trees, shrubs*; - recreation areas*; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - water protection zones and collection points.
	Low *Max. quantity of soil improvers required per year 13/ton/ha*	**Low**	- parks with lawns, lawns for underground facilities coverings, buried plant containers, roundabouts, traffic islands; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***	- restoration of quarries used as recreational or natural areas (wildlife shelter); non-productive grasslands, agricultural areas with low productivity *; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***

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PARAMETERS	MAP UNIT CLASS	INTRINSIC QUALITY CLASS	REUSE IN GREEN URBAN AREAS	REUSE IN GREEN PERI-URBAN, EXTRA-URBAN AND RURAL AREAS
Maps of Nitrogen, Phosphorus and Potassium content (NPK) The maps provide the content of K and P (mg/kg) and N (%) of the soils of Emilia-Romagna plain https://agri.regione.emilia-romagna.it/Suoli/	**P** > 23 mg/kg **K** > 120 mg/kg **N** > 0,5%	**High**	- vegetable gardens, gardens, nurseries, parks; - urban flowerbeds; - hanging gardens; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes.	- agricultural areas with annual rotation, vegetable gardens, nurseries, gardens, landscape restoration to recreational or natural areas with particularly demanding plant species, or used for agricultural use with annual rotation; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes.
	P > 23 mg/kg **K** > 120 mg/kg **N** > 0,5%	**Medium**	- vegetable gardens, parks, gardens, sports and recreation areas *; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - water protection zones and collection points; - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - green of industrial and craft areas, also as protection against noise and odors.	- agricultural areas (land improvement), gardens, forestry, horticulture, landscape restoration with grasslands, cultivated fields, trees, shrubs*; - recreation areas*; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - water protection zones and collection points.
	No requirements	**Low**	- parks with lawns, lawns for underground facilities coverings, buried plant containers, roundabouts, traffic islands; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***	- restoration of quarries used as recreational or natural areas (wildlife shelter); non-productive grasslands, agricultural areas with low productivity *; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***

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PARAMETERS	MAP UNIT CLASS	INTRINSIC QUALITY CLASS	REUSE IN GREEN URBAN AREAS	REUSE IN GREEN PERI-URBAN, EXTRA-URBAN AND RURAL AREAS
Soil texture class map The map of soil texture class (0-30 cm) represents the areal distribution of the grain size classes classified according to the USDA methodology for the soil of the Emilia-Romagna plain https://datacatalog.regione.emilia-romagna.it/catalogCTA/ (portale minERva)	**SiCL, CL, SL, SCL, SiL, L**	**High**	- vegetable gardens, gardens, nurseries, parks; - urban flowerbeds; - hanging gardens; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes. **NOTE**: IF SOM < 2.5 % TOPSOIL INTRINSIC QUALITY CLASS IS MEDIUM	- agricultural areas with annual rotation, vegetable gardens, nurseries, gardens, landscape restoration to recreational or natural areas with particularly demanding plant species, or used for agricultural use with annual rotation; - green of industrial and craft areas, **high quality** green belts. ***Naturalistic and landscape works*:** - areas under strict protection, respect and protection of waters and collection points (according to Legislative Decree 152/06 article 94) when the area is significant in terms of water flow and quality or areas of protection of waters for naturalistic purposes. **NOTE**: IF SOM < 2.5 %, TOPSOIL INTRINSIC QUALITY CLASS IS MEDIUM
	SL, LS, L, SiC, SC, CL, SiCL, CL, C (MAX 50%)	**Medium**	- vegetable gardens, parks, gardens, sports and recreation areas *; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - water protection zones and collection points; - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - green of industrial and craft areas, also as protection against noise and odors. **NOTE**: IF SOM < 2.0 %, TOPSOIL INTRINSIC QUALITY CLASS IS LOW	- agricultural areas (land improvement), gardens, forestry, horticulture, landscape restoration with grasslands, cultivated fields, trees, shrubs*; - recreation areas*; - parts of urban land for trees and tree lines (traffic islands, green strips next to sidewalks). ***Naturalistic and landscape works:*** - banks and flood protection areas, re-naturalization areas (with adequate drainage system) **; - water protection zones and collection points. **NOTE**: IF SOM < 2.0 %, TOPSOIL INTRINSIC QUALITY CLASS IS LOW
	LS, SL, L, SiL, SC, CL, SiCL, SiC, C (MAX 50%)	**Low**	- parks with lawns, lawns for underground facilities coverings, buried plant containers, roundabouts, traffic islands; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***	- restoration of quarries used as recreational or natural areas (wildlife shelter); non-productive grasslands, agricultural areas with low productivity *; - sports areas (only with clay <27% or silt <50%); - dirt road for pedestrian streets and cycle paths; - green of non-wooded industrial and craft areas; - anti-noise turfed barriers **; - areas under platform roofs and parking subgrades; - filling as subsoil layer under topsoil - green channel, rain gardens, dry swale, wet swale and other drainage systems ***

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*** Dry swale are realized over well-drained permeable soils, wet swale over poorly drained soils; rain gardens are essentially small wet swales

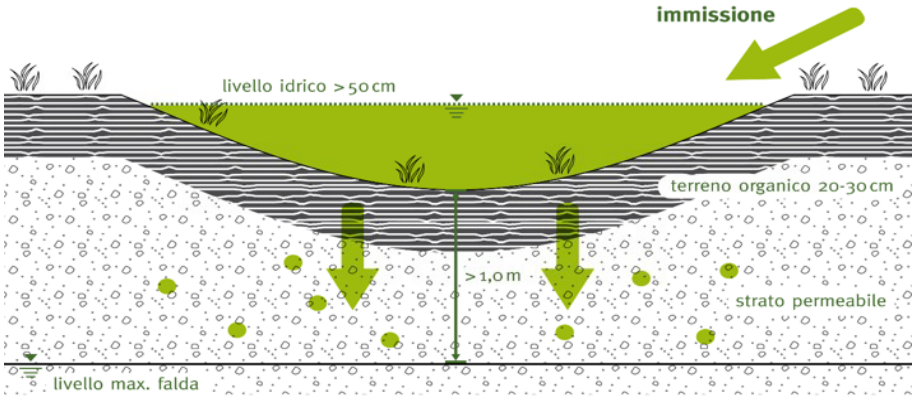


Figure 23. Cross section of a grass channel or, as principle, of a dry swale (source: Provincia Autonoma di Bolzano, Gestione sostenibile delle acque meteoriche in http://ambiente.provincia.bz.it/acqua/gestione-sostenibile-acque-meteoriche.asp). These systems are used on permeable soils. The dispersion in swale is indicated for the infiltration of rain water collected from large surfaces (over 1 ha), while the grass channels are particularly indicated next to long waterproofed surfaces (the swale functions like the channel, but it is larger and deeper). The swale and the channel are made on a permeable base with a superficial layer of organic soil between 20 and 30 cm thick. They are generally dry; after the rain it is generally empty within a few hours or at most within two days.

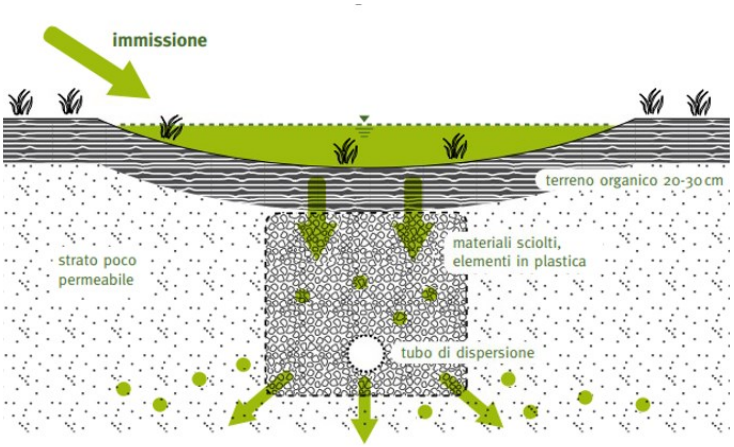


Figure 24. Cross section of a wet "grass channel" or, as a principle, of a wet swale (source: Provincia Autonoma di Bolzano, Gestione sostenibile delle acque meteoriche in http://ambiente.provincia.bz.it/acqua/gestione-sostenibile-acque-meteoriche.asp). These channels and swale are used on more impermeable soils and, to allow a better flow towards the discharge of rainwater, they are equipped with a small diameter dispersion pipe that flows slowly into the drains.

Figure 25. Dry swale with meadows and taller trees as they remain submerged by rains for shorter time, and rear of the emission pipe leading to rainwater discharge pipes. (Photo: Nazaria Marchi, near Ferrara).

Figures 26 and 27. Dry swale, Harrier Hill Park a Stockport, Columbia, USA.- Rain garden near Tivoli-Rome (codiferro.it).

Figures 28 and 29. Wet swale in Theix, park of a shopping mall (bigpaysage.canalblog.com) - Flowerbed, Nashville, Usa (cleanwaternashville.org).

Figure 30. Construction of river banks using excavated soil by Gescher, Germany (Huesker Engineering, huesker.it)

Figures 31 and 32. High Line in New York, renaturalization of the former railway viaduct, USA

Figures 33 e 34. Green roof, Lake City, Florida, Usa (moorefarmsbg.org) – Bridge side embankment, (Linee Guida dell'Ambiente e Paesaggio nei settori Infrastrutturali, Ispra 2010)

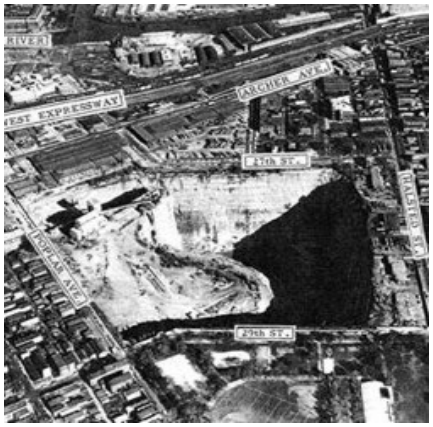
Figure 35. Construction of a noise and anti-glare barrier along the Turin-Mlan highway (source: Linee Guida dell'Ambiente e Paesaggio nei settori Infrastrutturali, Ispra 2010)

Figure 36. Portello Park in Milan with mounds built with excavated soils, on the area abandoned by the Alfa Romeo factories in the eighties

Figure 37. Artificial dunes along the highway by the Technogym factory, Cesena.

Figures 38 and 39. Slight reliefs in the park made with soil from excavations, University of New Mexico, Smith Plaza, Surface Design Inc.- Small dunes and semi-green roof, Odette Vinery, Napa, California.

Figures 40 e 41. Small dunes for acrobatic biking, Bike Jam, Malaga, Spagna –Bike and Pedestrian Trail Bodega Bay, California.



Figures 42, 43 and 44. Park on the former dolomitic limestone Stearns Quarry, Palmisano Park, Chicago, Usa

6. Tutorial for consulting the websites of Regione Emilia-Romagna

The purpose of this tutorial is to guide the user in retrieving soils data and maps available in the regional websites in order to get the information needed to apply the guidelines for the removal, management and reapplication of topsoil according to matrix illustrated in the previous paragraph.

The DGCTA web portal minERva aims to disseminate and distribute information and databases of the G.D. Land and Environment Care to the wide public and to the staff of local and national public administrations. Through the portal, it is possible to access all the regional thematic and applicative maps, including soil maps.

Access to the web portal is through the following URL:
https://datacatalog.regione.emilia-romagna.it/catalogCTA/

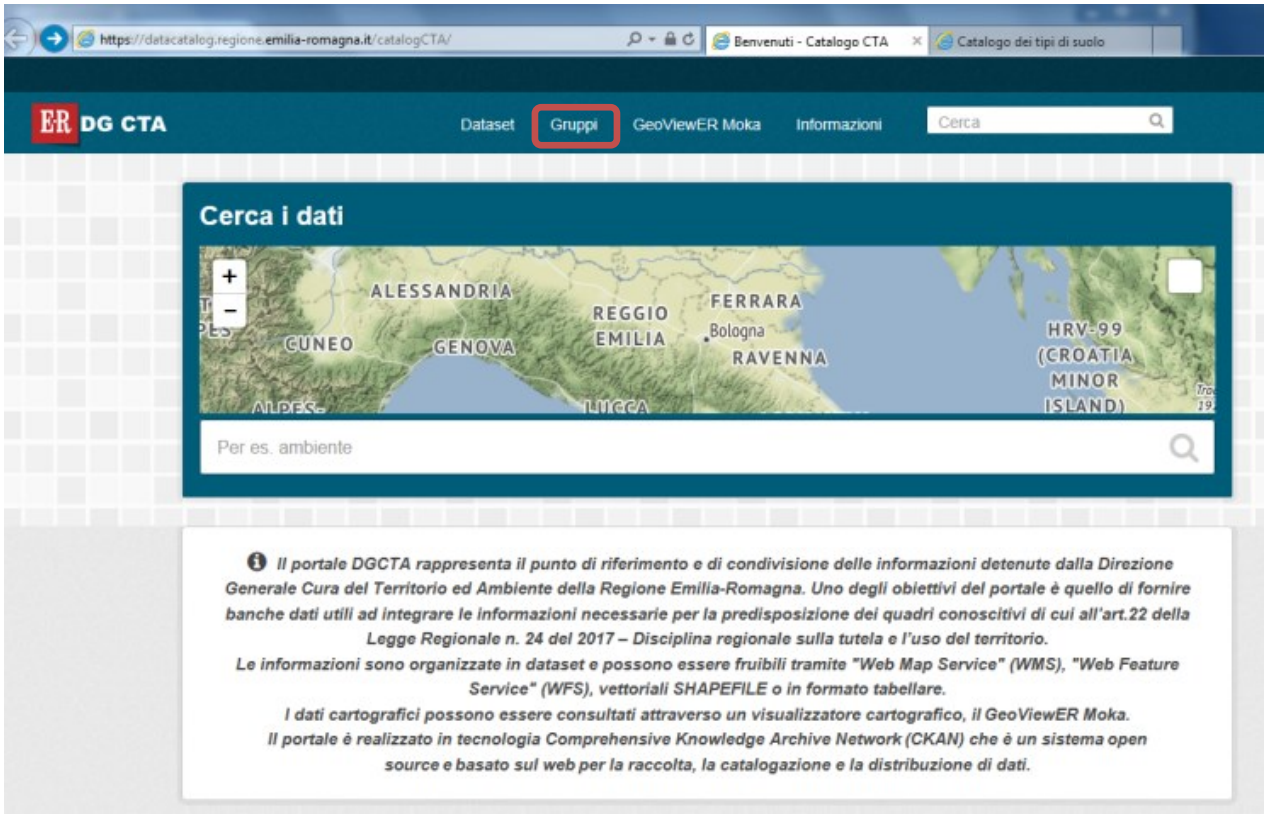


Figure 45.

In the first web page (Fig. 45) the menu in upper bar allows to access and navigate the contents of the portal. Selecting the menu "**Gruppi**" the user has access to 33 different catalogs (https://datacatalog.regione.emilia-romagna.it/catalogCTA/group); on the second page the group "**Suolo**" is available to access soil related data and maps (Fig. 46).

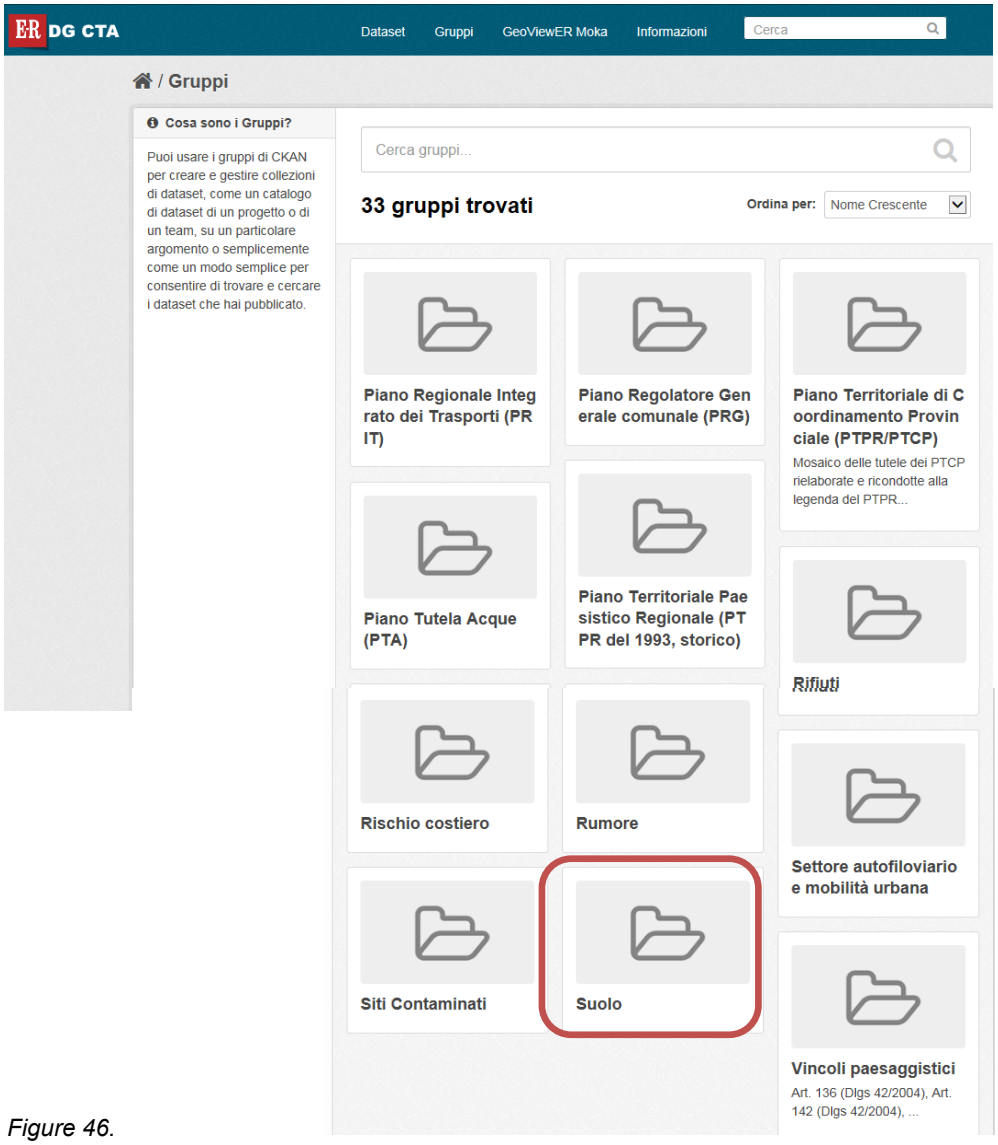


Figure 46.

At the page "**Suolo**", 14 datasets/maps are available (Fig. 47); these are available in different formats (HTML, WMS, KML, ESRI), but they all refer to the same page where all the formats made available to the user are listed (Fig. 48).

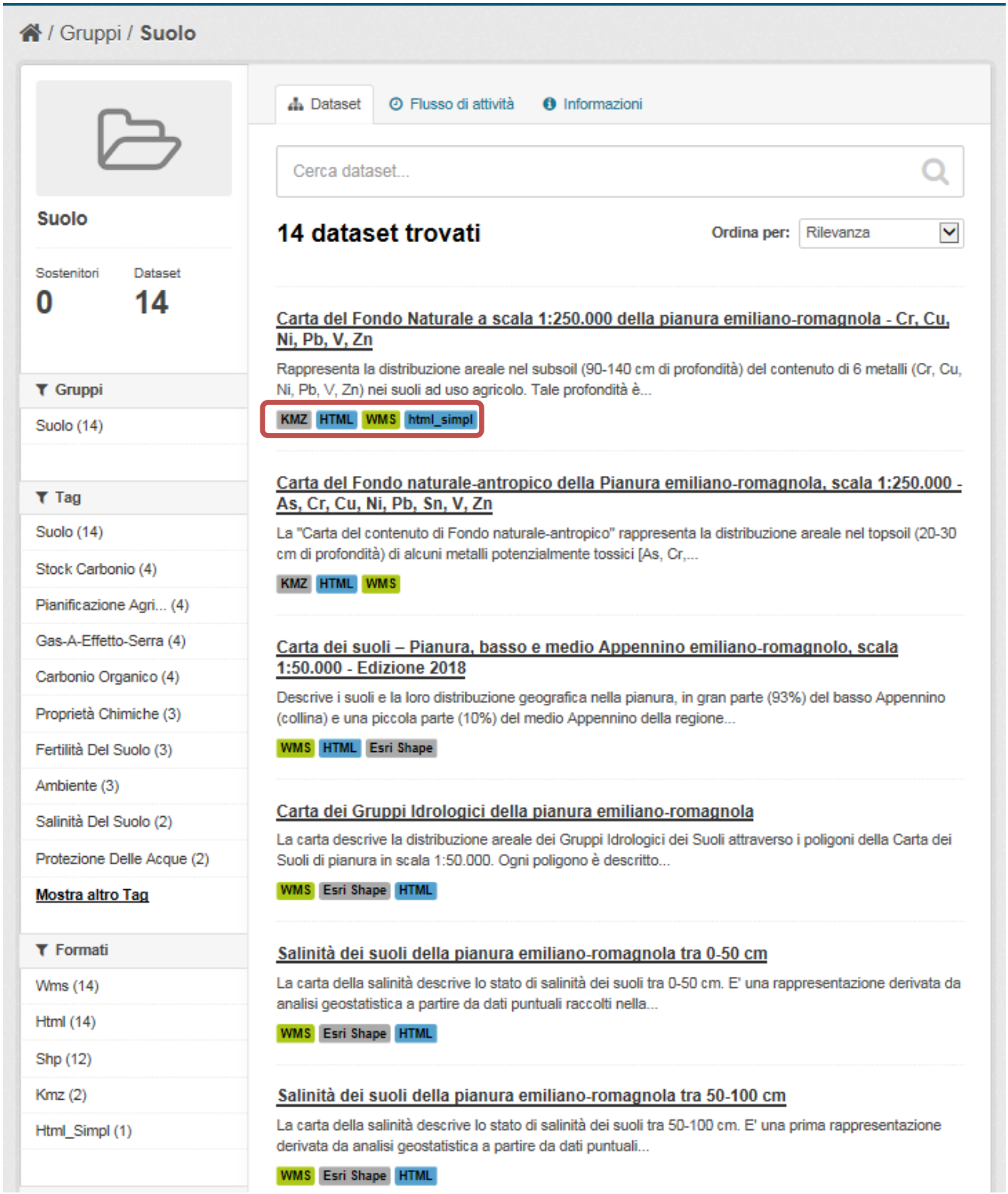

/ Gruppi / Suolo
Suolo
Sostenitori
0
Dataset
14
Gruppi
Suolo (14)
Tag
Suolo (14)
Stock Carbonio (4)
Pianificazione Agri... (4)
Gas-A-Effetto-Serra (4)
Carbonio Organico (4)
Proprietà Chimiche (3)
Fertilità Del Suolo (3)
Ambiente (3)
Salinità Del Suolo (2)
Protezione Delle Acque (2)
Mostra altro Tag
Formati
Wms (14)
Html (14)
Shp (12)
Kmz (2)
Html_Simpl (1)
Dataset
Flusso di attività
Informazioni
Cerca dataset...
14 dataset trovati
Ordina per: Rilevanza
Carta del Fondo Naturale a scala 1:250.000 della pianura emiliano-romagnola - Cr, Cu, Ni, Pb, V, Zn
Rappresenta la distribuzione areale nel subsoil (90-140 cm di profondità) del contenuto di 6 metalli (Cr, Cu, Ni, Pb, V, Zn) nei suoli ad uso agricolo. Tale profondità è...
KMZ HTML WMS html_simpl
Carta del Fondo naturale-antropico della Pianura emiliano-romagnola, scala 1:250.000 - As, Cr, Cu, Ni, Pb, Sn, V, Zn
La "Carta del contenuto di Fondo naturale-antropico" rappresenta la distribuzione areale nel topsoil (20-30 cm di profondità) di alcuni metalli potenzialmente tossici [As, Cr,...
KMZ HTML WMS
Carta dei suoli – Pianura, basso e medio Appennino emiliano-romagnolo, scala 1:50.000 - Edizione 2018
Descrive i suoli e la loro distribuzione geografica nella pianura, in gran parte (93%) del basso Appennino (collina) e una piccola parte (10%) del medio Appennino della regione...
WMS HTML Esri Shape
Carta dei Gruppi Idrologici della pianura emiliano-romagnola
La carta descrive la distribuzione areale dei Gruppi Idrologici dei Suoli attraverso i poligoni della Carta dei Suoli di pianura in scala 1:50.000. Ogni poligono è descritto...
WMS Esri Shape HTML
Salinità dei suoli della pianura emiliano-romagnola tra 0-50 cm
La carta della salinità descrive lo stato di salinità dei suoli tra 0-50 cm. E' una rappresentazione derivata da analisi geostatistica a partire da dati puntuali raccolti nella...
WMS Esri Shape HTML
Salinità dei suoli della pianura emiliano-romagnola tra 50-100 cm
La carta della salinità descrive lo stato di salinità dei suoli tra 50-100 cm. E' una prima rappresentazione derivata da analisi geostatistica a partire da dati puntuali...
WMS Esri Shape HTML

Figure 47.

Figure 48.

Among the option available, selecting "**Cartpedo**" the user is directed to the page with the link to the map repository *Cartpedo* (*https://geo.regione.emilia-romagna.it/cartpedo/*, reachable directly via the drop down menu on the right under "download" (Fig. 49).

From the first page of "Cartpedo", the user can proceed further selecting the:

1. "**Carte applicative**" (click on "**visualizza le *carte applicative* [*18*]"**), at the lower right under "**Carte tematiche II**" (Fig. 49) for the soil capability map (Fig. 50) and for the soil organic matter (SOM) map (0-30 cm);

2. "**Carte delle proprietà chimico-fisiche**" (click on "visualizza le *carte delle proprietà chimico-fisiche* **[*13*]**)" at the lower left under "**Carte tematiche I**", for the map of soil texture class and for the maps of the natural background values of heavy metals.

All maps refer to the soil of the Emilia-Romagna plain.

Figure 49. Screenshot of the access page of the soil maps repository "Cartpedo"

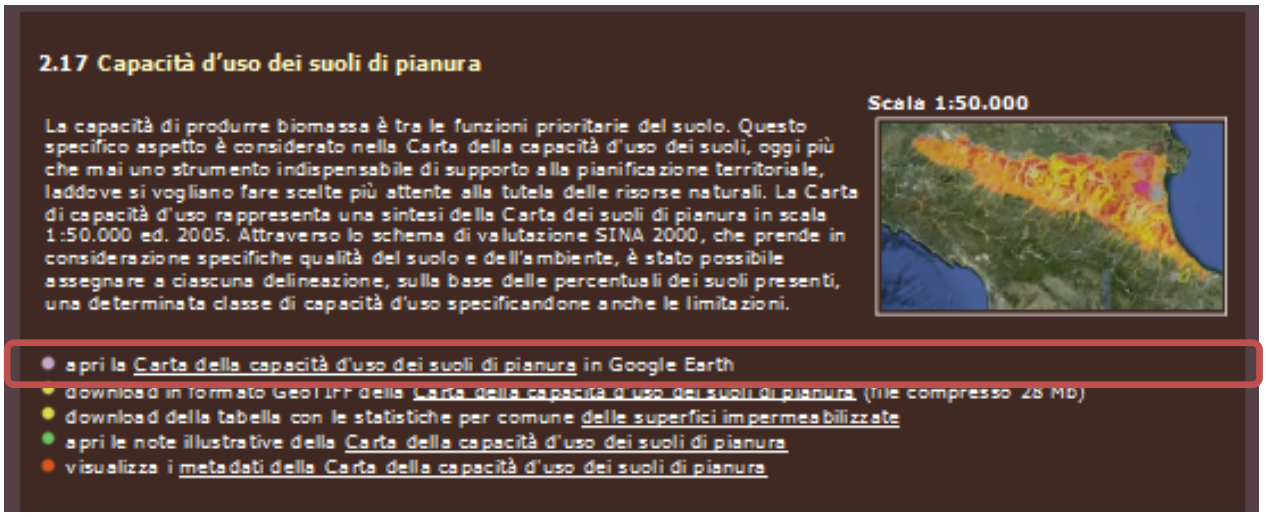


Figure 50. Access to the soil capability class map.

For all the maps the visualization is opened in GoogleEarth, and for each map the query is based on the minimum map unit (i.e. polygon/cell or finite square element, *fse*).

In the case of the soil capability map, the user will be shown the following screenshot:

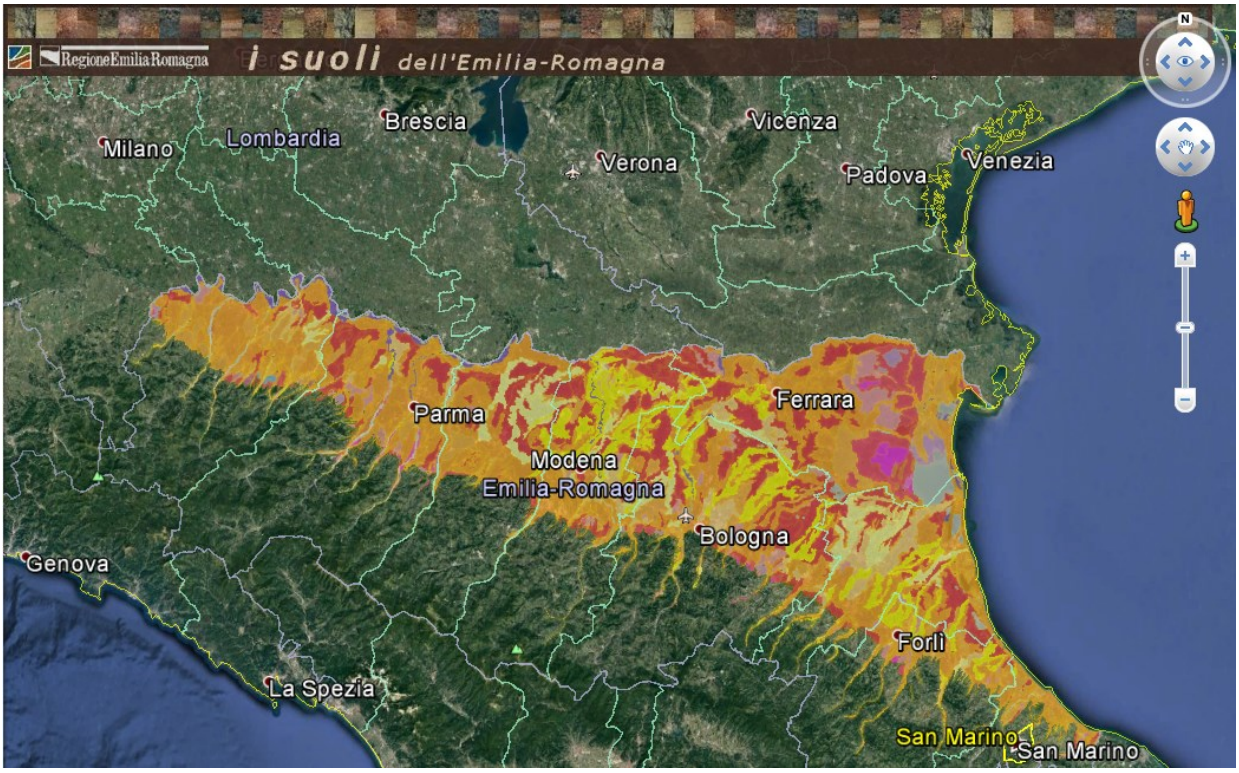


Figure 51. Soil capability map of the soil of the Emilia-Romagna plain in GoogleEarth.

The user can then zoom to the area of interest and click exactly on the poligon/cell where the working site is (topsoil production site, Fig. 52) and verify the soil capability class and the underlying limitations to use.

Figure 52. Example of topsoil production site in the municipality of San Lazzaro di Savena (BO).

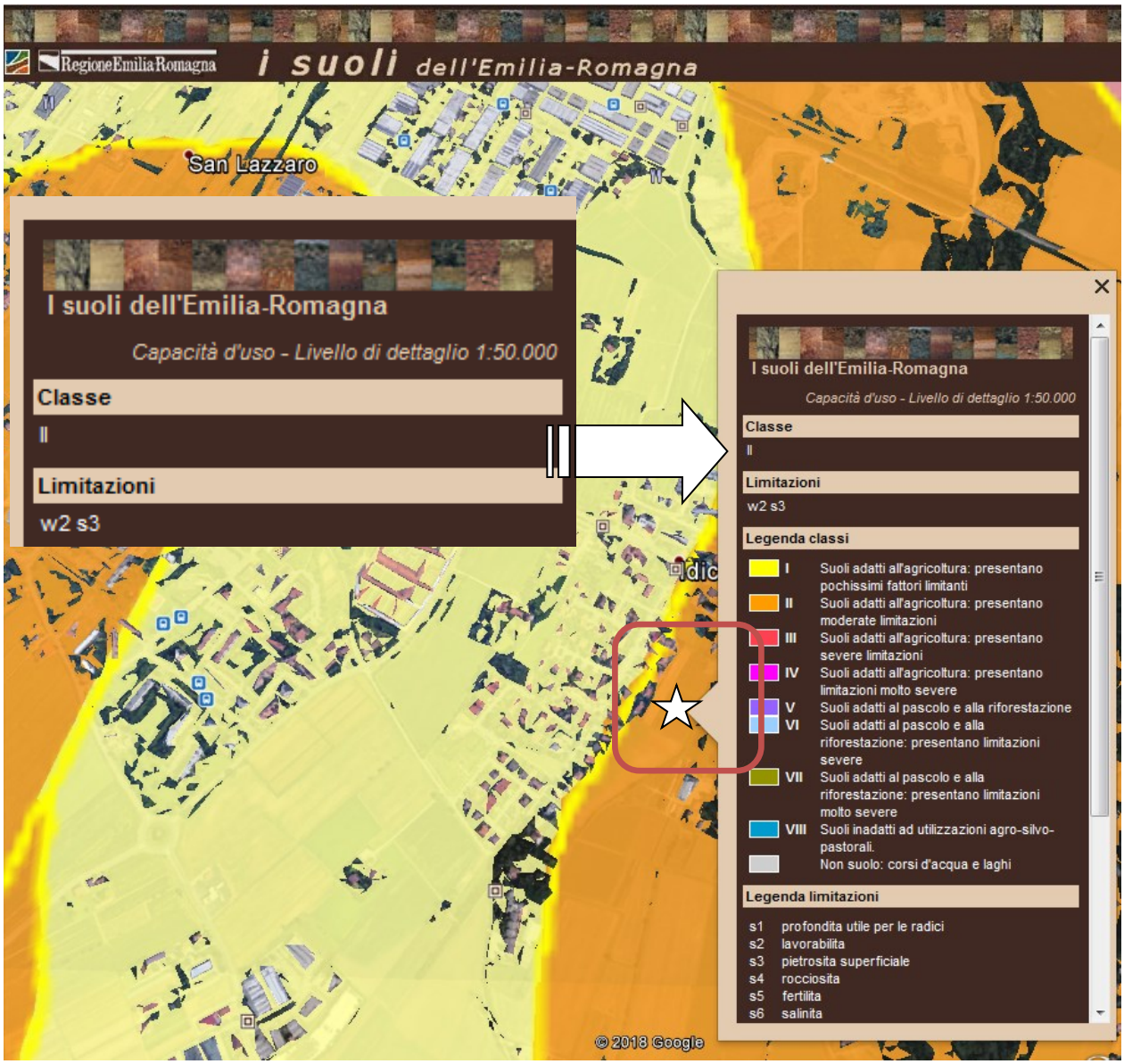


Figure 53. Example of query of the soil capability map at a topsoil production site in the municipality of San Lazzaro di Savena (BO).

As for the soil texture class map, the query for the same topsoil production site returns the result shown in figure 54.

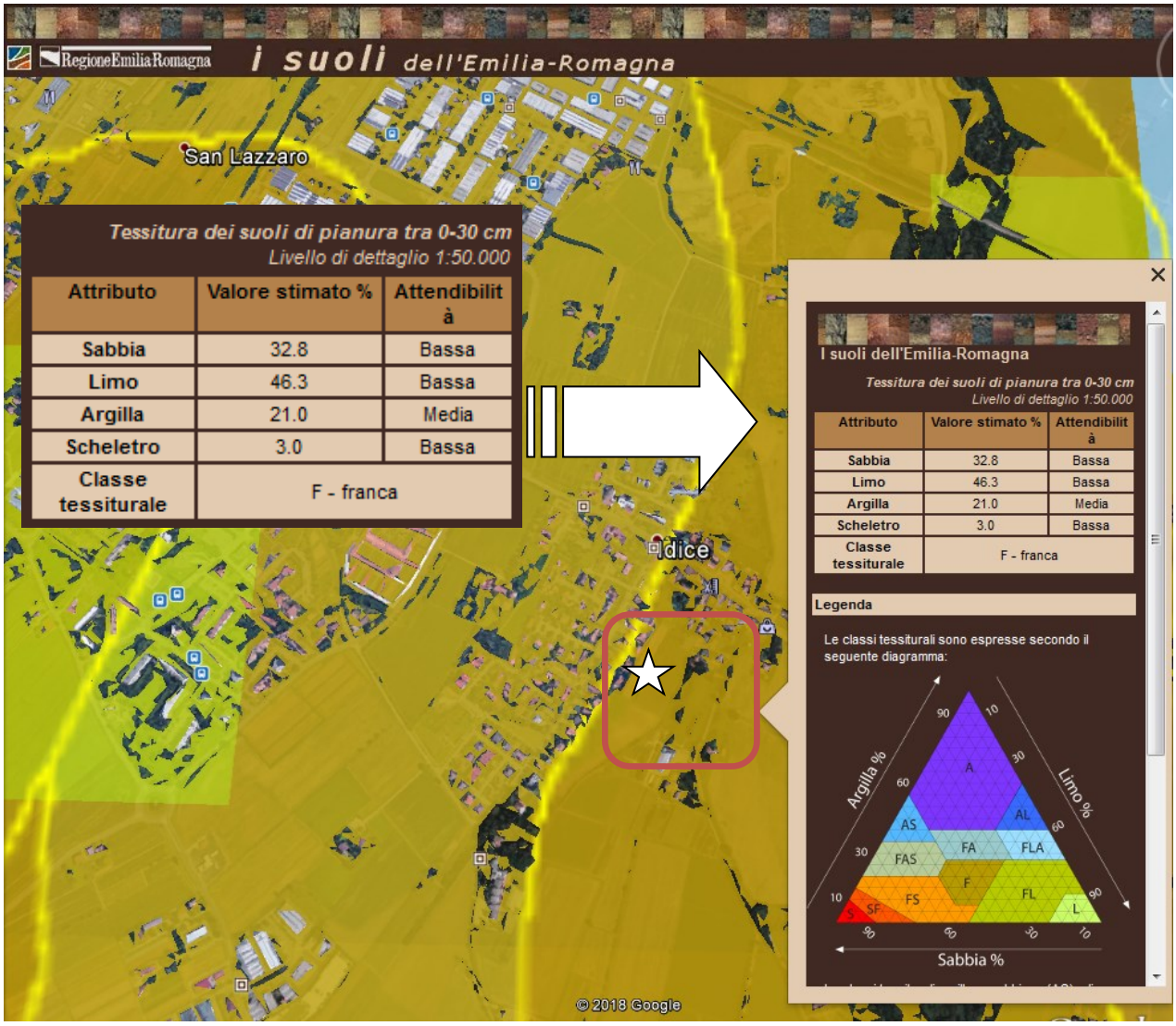


Figure 54. Example of query of the soil texture class map (0-30 cm) at a topsoil production site in the municipality of San Lazzaro di Savena (BO).

In the case of SOM content, the query at the same topsoil production site will return the screenshot shown in figure 55.

Figure 55. Example of query of the SOM content map (0-30 cm) at a topsoil production site in the municipality of San Lazzaro di Savena (BO).

In order to assess the topsoil contents of fertility elements (N, P, K), the user has to make his query at the URL https://agri.regione.emilia-romagna.it/Suoli/. The web page shows the map in scale 1:50.000 of the soils of the Emilia-Romagna plain (Fig. 56); from the menu on the right side the user selects one by one the thematisms in the folder “suoli”: K_2O content (mg/kg), P_2O_5 content (mg/kg) e N content (g/kg). As an example, figure 57 shows the result of the query for a topsoil production site in the municipality of San Lazzaro di Savena (BO).

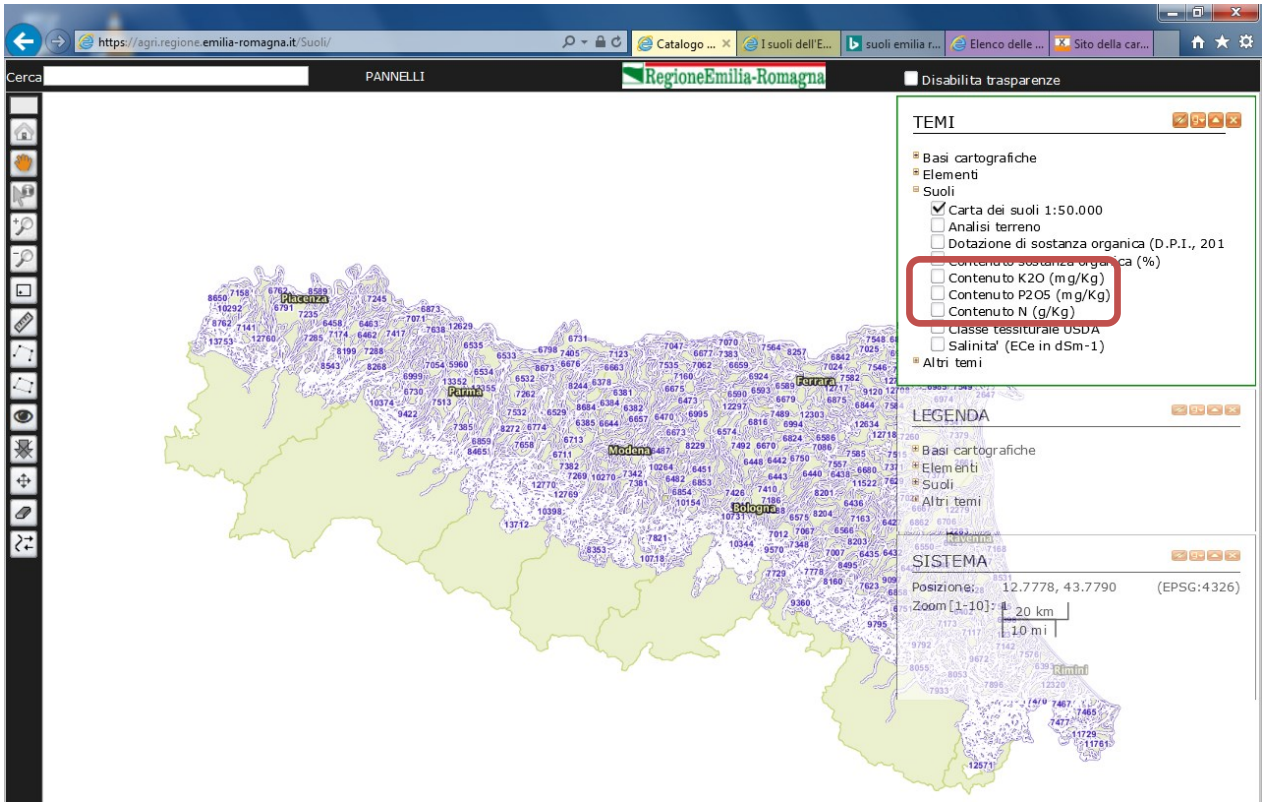


Figure 56. Start page https://agri.regione.emilia-romagna.it/Suoli/

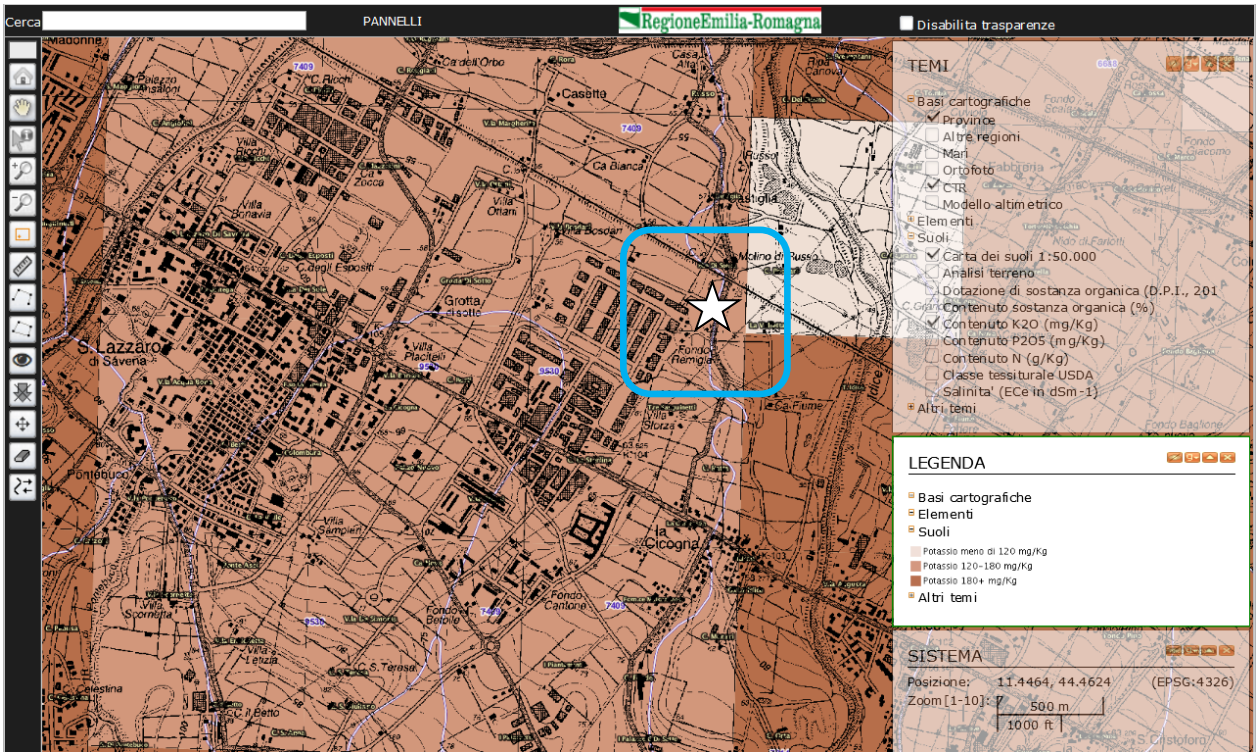


Figure 57. Example of query of the map of K content (0-30 cm) at a topsoil production site in the municipality of San Lazzaro di Savena (BO).

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Authors

Coordination:
Nazaria Marchi[1]

Text by:
Fernanda Canino[4], Daniela Cardinali[2], Nazaria Marchi[1], Pasquale Ricciato[3], Gioia Sambenedetto[3], Fabrizio Ungaro[5].

1 Servizio Geologico, Sismico e dei Suoli - **Regione Emilia-Romagna**
2 Servizio Pianificazione Territoriale e Urbanistica, dei Trasporti e del Paesaggio, Direzione Generale Cura del territorio e dell'ambiente - **Regione Emilia-Romagna**
3 Servizio Urbanistica e Edilizia Privata - **Comune di Forlì**
4 Servizio Urbanistica - **Comune di San Lazzaro di Savena**
5 **CNR Ibimet**

Have joined the work of the working group Action B.2.4
Comune di Carpi: Norberto Carboni
Legambiente Emilia-Romagna: Lorenzo Frattini

Annexes

Annex 1 – Pedological report
Allegato 2 – Working site *vade mecum* for soil protection

December 2018

SOS4LIFE Project Partners

Comune di Forlì
Servizio Urbanistica e edilizia privata
Unità Riqualificazione urbana
(Lead Partner)
Corso Diaz, 21 - 47121 Forlì (FC)
Contact: Stefano Bazzocchi
phone: 0543-712447
stefano.bazzocchi@comune.forli.fc.it

Regione Emilia-Romagna
Servizio Pianificazione territoriale e urbanistica, dei trasporti e del paesaggio
Viale Aldo Moro, 30
Contact: Roberto Gabrielli
phone: 051 – 5276049
roberto.gabrielli@regione.emilia-romagna.it

Comune di Carpi
Area Urbanistica e LLPP
Servizio Pianificazione e Sviluppo Urbanistico
Corso Alberto Pio, 91, 41012 Carpi MO
Contact: Norberto Carboni
phone: 059-649147
norberto.carboni@comune.carpi.mo.it

CNR Ibimet
via Giovanni Caproni 8 - I-50145 Firenze
Contact: Costanza Calzolari
phone: 055 5226559
c.calzolari@ibimet.cnr.it

Comune di San Lazzaro di Savena
Area Programmazione del Territorio
Settore Pianificazione e Controllo del Territorio
Piazza Bracci 1 - 40068 San Lazzaro di Savena
Contact: Anna Maria Tudisco
phone: 051 6228050
annamaria.tudisco@comune.sanlazzaro.bo.it

Legambiente ER
Via Massimo Gorki, 6 – 40128 Bologna (BO)
Contact: Lidia Castagnoli
phone: 051 241324
l.castagnoli@legambiente.emiliaromagna.it

Forlì Mobilità Integrata
Piazza Saffi, 8 - 47121 Forlì (FC)
Contact: Claudio Maltoni
phone: 0543 712557
claudio.maltoni@comune.forli.fc.it

Ance ER
Via Ferruccio Parri 31 - 40128 Bologna (BO)
Contact: Giulio Capello
phone: 051 6311464
direzione@ance.emr.it

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