LIFE Project Number

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Deliverable "Database on soil threats in the project area"

Sub-action A1.1 "Soil threats in the project area"

LIFE+ PROJECT Soil4Wine

Sommario

List of abbreviations....2
List of additional materials....2
1. Introduction: Project overview....3
2. Description of the project area - The vineyards in "Parchi del Ducato"....3
3. Description of the assessment process....4
3.1 General vineyard informations....4
3.2 Visual Assessment....6
3.3 Data collected using thematic maps....6
5. Outcomes on mail soil threats in project area....7
6. Photographic vineyards Database....21
7. Conclusions....22
8. Essential bibliography....23
9. List of Figures....23
9. List of Tables....23

List of abbreviations

UCSC	Università Cattolica del Sacro Cuore
HORTA	HORTA Srl
EGPB	Ente di gestione per i Parchi e la Biodiversità Emilia Occidentale
ERVET	ERVET SpA - Emilia Romagna Valorizzazione Economica del Territorio
VT	"Val Trebbia"
ST	"Stirone-Piacenziano"
TBC	"Taro" and "Boschi di Carrega"

List of additional materials

- Database of soil threats
- Photographic Database
- kml file of surveyedv vineyards

1. Introduction: Project overview

Soil4Wine project "*Innovative approach to soil management in viticultural landscape*" is aims to achieve a better soil management in the whole viticultural system developing and testing an innovative Decision tool and management solution tested in farm in Project area and Europe.
This report presents the structure and main outcomes of sub-action A1.1 related to Soil4Wine project Action A.1 "Study on the soil threats and constitution of the stakeholder groups" from M1 (01.01.2017) until M3 (31.03.2017).
Action A.1 will continue until M6 of the project (30.06.2017) with the production of a new Deliverable for the following sub-action A1.2.
UCSC is the responsible for this action, while other partners involved are HORTA, EGPB, VINIDEA and ERVET.
Aim of this sub-action was the creation of an open-source database including information regarding the main soil and related environmental threats in the project area.

2. Description of the project area - The vineyards in "Parchi del Ducato"

The project area is defined by 4 protected areas of western Emilia-Romagna:

- "Boschi di Carrega"
- "Taro"
- "Stirone-Piacenziano"
- "Val Trebbia"

Based on the cartography and documents previously produced by the Emilia-Romagna Region, the study area can be characterized as follows:
- Land capability. The ability of the soil to support agricultural activities based on intrinsic characteristics, such as depth, fertility, etc., and environmental characteristics, such as elevation, sun exposure, slope, proneness to landslide and erosion, etc. is severely limited and requires proper management, with soil conservation practices difficult to be applied and maintained;
- Orography and elevation. Elevation ranges between 100 to 600 m above sea level, with varying slopes until 30%.
- Soil types. There are four prevalent soil types in the study area, called “terre rosse antiche” (ancient red soils); “terre fossili del Piacenziano” (fossil Piacentianum soils;); “terre argillose della Val Tidone” (clay Val Tidone soils) and “terre del basso Appennino” (low Apennines soils). Soil texture is characterized by fine size particles, with prevalence of clay soils. The content of organic matter (OM) is patchy, with prevalence of soil with less than 1.5% (the average of OM found in the hilly soil of the Parma and Piacenza districts is 0,99% and 1,29%, respectively);
- Erosion potential (in terms of soil lost each year per ha because of water) is intermediate (20 or 50 t/ha) or high (>50 t/ha), with zones with prevalence of landslides (about 80% and 70% of the land in the districts of Piacenza and Parma, respectively, show prevalence of landslide). (Figure 1)

Figure 1: Stirone Piacenziano landscape and badlands

3. Description of the assessment process

First objective of *Soil4Wine* project is the identification of the main soil threats in the project area. In order to do that UCSC and HORTA have performed a survey (March 2017) on several vineyards belonging to farms located in the project area and identified with the collaboration of EGPB.
The survey was composed by: i) a questionnaire for winegrowers aimed at describing vineyards characteristics and identifying main agronomical practices performed, as well as investigating winegrower's perception of their own vineyards' soil health, and ii) a visual assessment score-card for the identification of vineyard features and conditions.
Surveyed vineyards were also geo-referenced using GPS coordinates (in WGS84 coordinate systems) and some information were collected through regional maps and geographical software such as Google Earth and GIS.
Data were included in a database designed with Excel software.

3.1 General vineyard informations

- Farm and vineyard's features

Surveyors have collected general data about the farms (such as geographical coordinates, location, size and aspect) and many specific vineyard parameters as listed in in Table 1. All these info were included in the database (attached to this deliverable as supplementary material).

Database Code	Description
ID_VINEYARD	Vineyard identification number
YEAR_PLANT	Year of planting
AGE_CLASS	Class of vineyard's age
VINE_VARIETY	Vine variety
ROOTSTOCK	Rootstock
TS	Trainings system
DIST_VINE	Vine distance in the row (meters)
DIST_MIDRROW	Vine distance between rows (meters)
DENSITY_HA	Vines/hectare
DENSITY_CLASS	Density class
AV_CIRC	Trunk circumference

COORD_N	North coordinate (WGS84)
COORD_E	East coordinate (WGS84)
ELEVATION_MIN	Maximum elevation (meters)
ELEVATION_MAX	Minimum elevation (meters)
ELEVATION_AVE	Average elevation (meters)
ASPECT	Aspect
SLOPE	Slope (°)
SLOPE_PER	Slope (%)
SLOPE_CLASS	Slope classification according to SOTER Model (ISRIC, 1995)
SOIL_TYPO_250	Soil (according to Regional Soil Map 1:250.000)
SOIL_TYPO_50	Soil (according to Regional Soil Map 1:50.000)
MID_NAT_GRASS	Mid-row natural grassing/cover crop
MID_SEED_GRASS	Mid-row seed grass/cover crops
MID_BARE_SOIL	Mid-row bare soil
ROW_NAT_GRASS	Row natural grassing/cover crop
ROW_SEED_GRASS	Row seed grass/cover crops
ROW_BARE_SOIL	Row bare soil
HEAD_NAT_GRASS	Headlands natural grassing/cover crop
HEAD_BARE_SOIL	Headlands bare soil
DRAINAGE	Drainage (yes/no)
IRRIGATION	Irrigation
SPRING_LOGGING	Spring water logging
WATER_STRESS	Water stress
NUTR_DEF	Nutritional deficiency
FERTIL	Fertilization
TILLAGE_MIDROW	Tillage localization on inter-row
TILLAGE_ROW	Tillage localization in the vine row
MACHYNERY	Type of tractor wheels used in vineyard
STONE	Incidence of stones
COMPACTION	Compaction of soil due to machine transit
GROOVE	Grooves
SLOT	Slots
TILLAGE	Tillage
EROSION_TYPO	Erosion intensity
MID_EROSION_LOC	Mid-row erosion
ROW_MID_EROSION_LOC	Mid-row and under the vine erosion
VINEYARD_HEAD_EROSION_LOC	Whole vineyard erosion
HEAD_EROSION_LOC	Headlands erosion only
CRUST	Crust intensity
STONE	Stone abundance

Table 1: Specific data collected for each assessed vineyard and included in the database

In addition to the data described above, information about agronomic practices performed during the season were asked to the farmer, such as use of irrigation (presence/typology of irrigation system), soil and canopy management operations.

Considering that surveys were performed in March, information regarding water and nutritional stress were asked directly to farmers and not assessed by surveyors.

- Winegrowers perception on soil's health

Surveyors directly asked winegrowers if they consider their soil suffering from any limitation and, in case, to specify the main threats that they noticed. Time-related factors are very important in terms of soil threats evolution; so it was also asked if they noticed a loss of soil health in vineyards mover time and if they feel that addressing these problems with agronomical techniques is a priority or not..

3.2 Visual Assessment

- Vineyard soil's features

Evaluation on soil features and main threats was performed through visual assessment according to FAO guidelines (FAO, 2008)
General features of soil were detected, such as presence of stone, compaction, grooves, slots and tillage.
Covering of soil was assessed taking into consideration the inter-row, the under-the-row and the headland areas, indicating for each of these if coverage was natural or seeded or if the soil was bare.
Features on erosion, crusting and stoniness were surveyed on 4 random spots of each vineyard and a question on the condition of vineyard during rainy or dry season was forwarded. Intensity of the threats was determined using a 3 level scale (0 no limitation - 3 strong limitation); erosion localization. Detailed photo-shooting was taken in each vineyard.

3.3 Data collected using thematic maps

Geographical coordinates were converted in .kml files in order to localize them in GIS environment. (Figure 2)

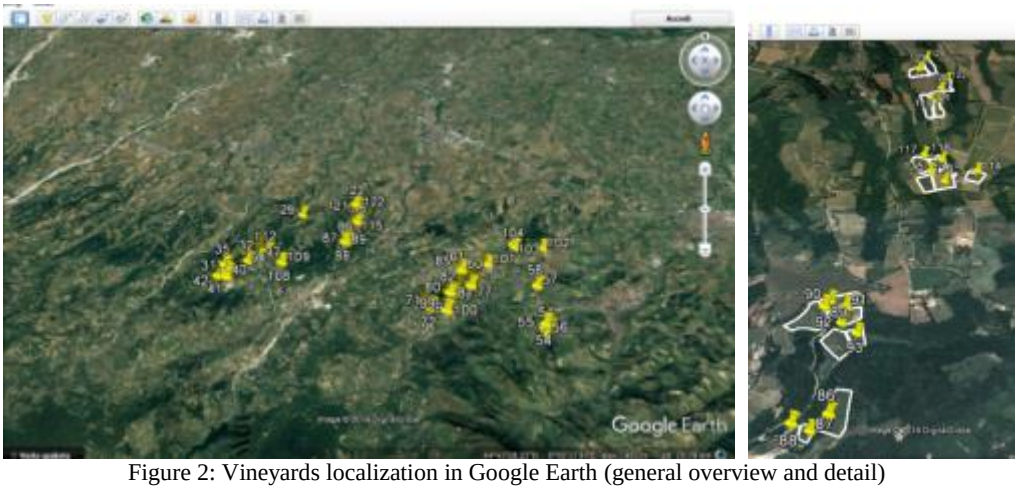

Figure 2: Vineyards localization in Google Earth (general overview and detail)

Minimum and maximum elevation were identified and slopes were calculated (both in sexagesimal grades and percentage).

Information on soil typologies and organic carbon content were derived by overlaying vineyards areas onto soil maps of Emilia Romagna Region using Google Earth services "CARTPEDO" made available by Regional Soil Office (http://geo.regione.emilia-romagna.it/cartpedo/).
For soil maps two different scales were used, 1: 250.000 covered all Region and 1:50.000 that covers only plain land.
Geo-localization allows also the measurement of vineyard surfaces.

5. Outcomes on mail soil threats in project area

The survey has been performed in the core area of the 4 parks and in bordering areas as well by visiting a total of 124 vineyards (in 23 farms): 12 in Trebbia Valley, 22 in "Taro" and "Boschi di Carrega" Park and 90 in "Stirone-Piacenziano" areas (Figure 3). Therefore, the number of total surveyed vineyards is in excess of the number (100) reported in the Project DoW.

Figure 3: Vineyards localization in the Project Area

- ***Vineyard characteristics***

Vineyards **age** was classified in 5 classes (Table 2): most of the surveyed vineyards have been planted 10-20 years ago (47.96%).

	Vine density classes					
Age of vines	**Class 1 1500-2500 vine/ha**	**Class 2 2500-3500 vine/ha**	**Class 3 3500-4500 vine/ha**	**Class 4 4500-5500 vine/ha**	**Class 5 5500-6500 vine/ha**	**Total/Age class**
0-5 years	0.37%	2.97%	6.69%	0.00%	0.00%	**10.04%**
5-10 years	0.37%	14.13%	2.23%	0.00%	9.29%	**26.02%**
10-20 years	2.23%	26.77%	5.58%	5.95%	7.43%	**47.96%**
20-30 years	3.35%	2.23%	0.00%	0.00%	0.00%	**5.58%**
30-50 years	3.35%	2.97%	1.12%	0.00%	0.00%	**7.43%**
No information	1.12%	0.74%	1.12%	0.00%	0.00%	**2.97%**
Total/vine density class	**10.78%**	**49.81%**	**16.73%**	**5.95%**	**16.73%**	**100.00%**

Table 2: Distribution of vine density and age classes.

In Figure 4 is described the distribution of age classes in slope classes.
Trunk's circumference at 20 cm from soil was measured randomly on 15 vines in each vineyard to assess the vigor class (Figure 5).

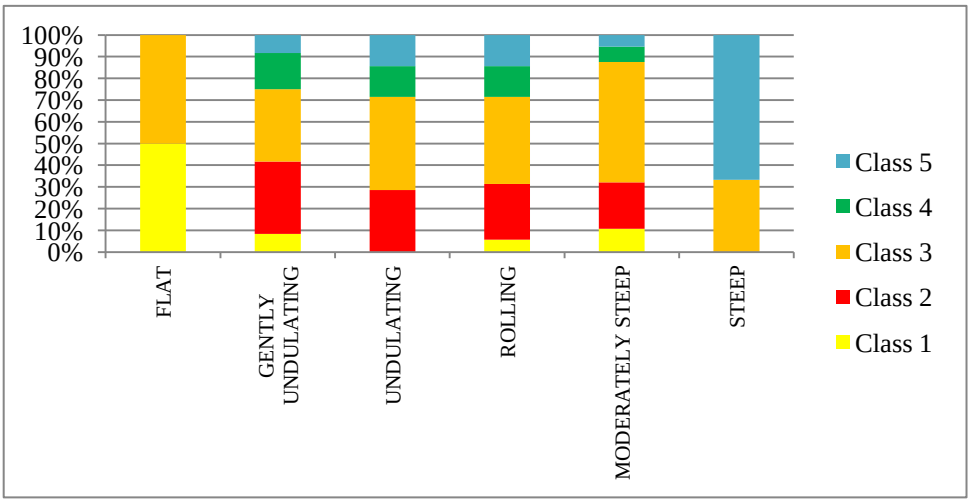

Figure 4: Distribution of Age classes in slope classes

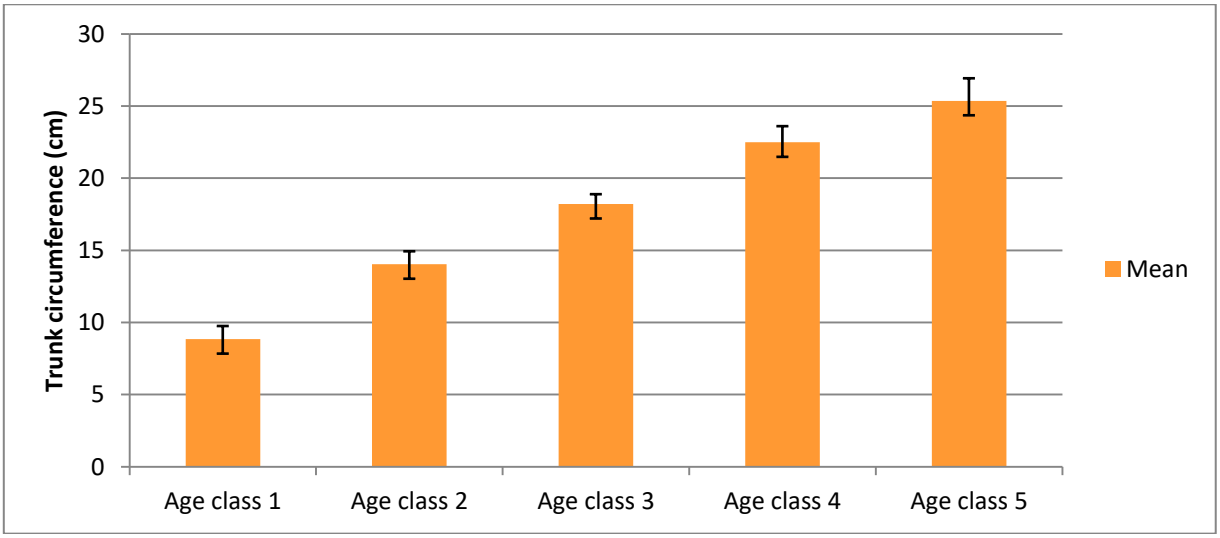

Figure 5:Variation of trunk circumference (cm) with progressive vineyard age increase. Vertical bars represent standard error (SE) around the mean

Analysis on **vine density/ha** (Table 3 and Figure 6) shows that most of the vineyards fall between 2.500 and 3500 vine/ha (Class 2) and are mostly located in moderately steep lands, also younger vineyards have a density between 3500-4500 vine/ha.
Guyot, simple or double, is the most represented **training** (91.94%), while the remaining fraction (8.06%) are spur-pruned permanent cordons.

	Density class					
Slope	**Class 1 1500-2500 vine/ha**	**Class 2 2500-3500 vine/ha**	**Class 3 3500-4500 vine/ha**	**Class 4 4500-5500 vine/ha**	**Class 5 5500-6500 vine/ha**	**Total/slope class**
FLAT	0.00%	0.00%	2.23%	0.00%	0.00%	**2.23%**
UNDULATING	0.37%	3.72%	1.12%	0.00%	0.00%	**5.20%**
GENTLY UNDULATING	1.12%	2.23%	2.23%	1.49%	5.58%	**12.64%**
ROLLING	4.46%	11.90%	2.23%	0.00%	9.29%	**27.88%**
MODERATELY STEEP	3.72%	29.74%	7.81%	4.46%	1.86%	**47.58%**
STEEP	1.12%	2.23%	1.12%	0.00%	0.00%	**4.46%**
Total/density class	**10.78%**	**49.81%**	**16.73%**	**5.95%**	**16.73%**	**100.00%**

Table 3:Distribution of vineyards in Density Classes and Slope classes.

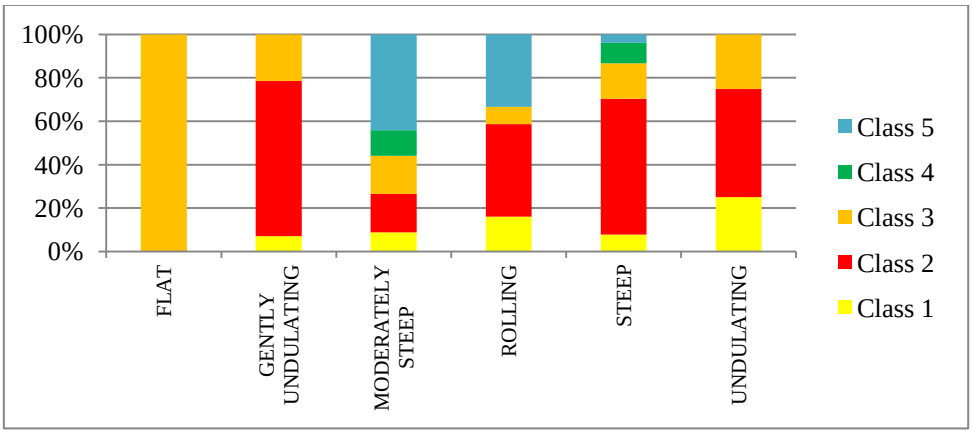

Figure 6: Distribution of Density classes in slope classes

Cultivars and and rootstock

In the surveyed vineyards main local grapevine varieties of Piacenza and Parma DOC/DOCG areas are cultivated: Croatina and Barbera as red varieties and Ortrugo, Malvasia and Sauvignon blanc as white varieties.
Usually vineyards are planted with more than one vine variety, to facilitate the production of local blended wines, such as Vin Santo di Vigoleno, Monterosso Val d'Arda, Trebbianino Val Trebbia and Gutturnio. Moreover, Kober5BB and SO4 or 420A are the most used rootstocks for older planting and for more recent vineyards, respectively.

Water management

Despite drainage is an important agricultural practice for a good management of rain water and prevention of water logging, only 35 vineyards over the 124 assessed (i.e., 28.22%) have drainage solutions represented by drains, trench systems or mole plows. (Figure 7)
Irrigation is not common in project area and only 20 vineyards have the possibility of watering vines during the dry season. Some vine-growers install dripping systems only during the first years after planting and remove them after about 5 years.
The project area is characterized by dry summers and, especially over the last decade, by dry winters also; therefore the majority of vine-growers (64.52%) have reported problems of water stress especially for young vineyards planted in sloping areas.

Figure 7: Drainage in vineyard n.80

Fertilization

Almost 71% of the surveyed vineyards are fertilized: with manure (46 vineyards), mineral inorganic fertilizers (24 vineyards) or mixed (mineral and organic) (15 vineyards) depending on presence of evident deficiency manifestation. Interesting is the presence in two vineyards of mychorriza and 1 vineyard in which fertilization is combined with a drip irrigation system.

Soil tillage

Tillage is performed in 89 vineyards (71.77% of total vineyards) and in 32 of these both inter-row and under the vine. Main tillage operations between vine-row are rotary tillage, ripping and grubbing. .
Tractor used for tillage operation have tracks (29.03%) mostly in high slope vineyards, tyres (34%) and in 37.10% of vineyards vine growers use tracks or tyres depending from the kind of tillage operation needed.

- ***Soil topography***

Elevation

Elevation has been registered using GPS and verified through Digital Terrain Model (resolution 5 meters) (Table 4).

Elevation	***VT***	***SP***	***TBC***
Maximum	238.08	272.00	211.63
Minimum	223.75	258.30	200.45
Average	230.92	262.18	206.04

Table 4: Elevation of vineyards in project area

Slope and aspect

Slope has been calculated through GIS for each vineyard surveyed. The Project area is characterized by steep agricultural areas (Figure 8) and this is confirmed by *in situ* evaluation.

Table 5 reports an average value of 15.59% for the whole Project Area, but analyzing data for each sub-area: VT reach an average value of 20.43% and maximum slope is registered in SP areas (35.15%).

Figure 8: Vineyard n.30 (Slope: 31.92%) and 86 (Slope: 35.15%)

Slope	***Project area***	***VT***	***SP***	***TBC***
Maximum	**35.13%**	32.18%	35.13%	29.36%
Minimum	**1.00%**	14.73%	1.00%	2.35%
Average	**15.59%**	20.43%	15.75%	12.30%

Table 5: Elevation of vineyards in project area

Slope intensity has been also classified according to SOTER Model (ISRIC, 1995) (Table 6):the majority of surveyed vineyard (42.97%) are classified as moderately steep, while , analyzing data for sub-area, in VT around 79% of vineyards are classified as moderately steep and 13% steep; in SP slope intensity is concentrated between gently undulating, rolling and moderately steep; in TBC vineyards are mainly "rolling" with slope between 8-15% (Table 7).

Denomination	***Code***	***Slope (%)***
Flat	F	0-2%
Gently undulating	G	2-5%
Undulating	U	5-8%
Rolling	R	8-15%
Moderately steep	S	15-30%
Steep	T	30-60%
Very steep	V	> 60%

Table 6: Slope Classification (SOTER)

	Project area	***VT***	***SP***	***TBC***
Flat	2.32%	0.00%	2.55%	0.00%
Gently undulating	11.73%	0.00%	11.32%	17.94%
Undulating	9.01%	0.00%	9.89%	0.00%
Rolling	29.56%	7.69%	27.29%	61.50%
Moderately steep	42.97%	79.49%	44.51%	20.55%
Steep	4.05%	12.82%	4.31%	0.00%

Table 7: Distribution of vineyards in Slope Classes

With a compass integrated in GPS device aspect of vineyards was also registered: vineyards are mainly oriented to East and South-East (20.16 and 18.55% respectively). (Figure 9)

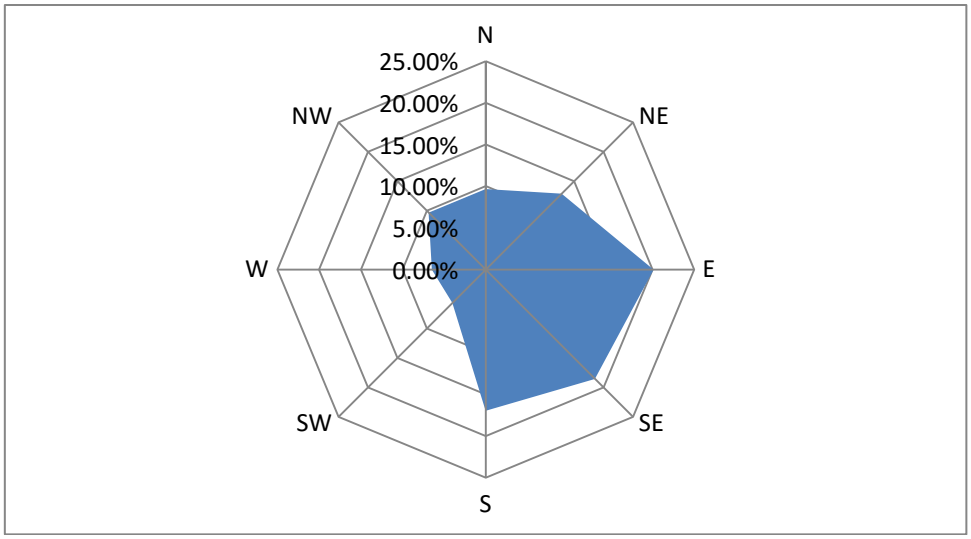

Figure 9: Aspect of vineyards in the Project Area

- ***Soil typologies***

Regional Soil Map (scale 1:250.000)

The Emilia-Romagna Region Soil Service has designated 91 Cartographic Units (http://geo.regione.emilia-romagna.it/cartpedo/legenda.jsp?liv=3); Table 8 describes the distribution of these Soil units in the project area.
The majority of the surveyed vineyards falls within the unit 5Aa characterized by high slopes (35-60%), low depth, calcareous soils and with medium texture.
In VT main soil unit is 6Ba, characterized by slope comprised between 8-20%, moderate depth with medium soil texture, calcareous, almost alkaline.
In TBC main soil unit is 5Ab, characterized by 15-25% slope calcareous, alkaline.

Cartographic units	*Project area*	*VT*	*SP*	*TBC*
3Bb	0.81%	-	1.11%	-
4Aa	4.84%	-	-	27.27%
4Ab	5.65%	-	1.11%	27.27%
4Ba	2.42%	-	-	13.64%
4Bb	13.71%	-	18.89%	-
5Aa	**21.77%**	-	**30.00%**	-
5Ab	18.55%	-	17.78%	**31.82%**
5Ac	16.94%	-	23.33%	-
5Ea	0.81%	8.33%	-	-
5Eb	4.84%	-	6.67%	-
6Ba	7.26%	**75.00%**	-	-
6Cb	1.61%	16.67%	-	-
No information	0.81%	-	1.11%	-
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 8: Soil cartographic units in the vineyards of Project area

Regional Soil Map (scale 1:50.000)

The Emilia-Romagna Region Soil Service has identified 369 soil types in Emilia Romagna Plain (http://geo.regione.emilia-romagna.it/cartpedo/catalogo_tipi_suolo.jsp).

Main represented soil in the surveyed vineyards is SFA1 (San Faustino) classified as *(2010) Udic* Haplustepts fine silty, mixed, active, mesic by Soil Taxonomy (USDA) and *(2007) Haplic Cambisols (Calcaric)* by WRB Classification.
In TBC sub-area main soil is MFA1 (Montefalcone) classified as *(2010) Udertic Haplustepts fine, mixed, superactive, mesic* by Soil Taxonomy and *(2007) Vertic Cambisols (Eutric)* by WRB.
Unfortunately, VT is not included in this Map.

Soil Organic Carbon (SOC%) 0-30 cm and Soil Organic Matter (SOM%)

Soil Organic Carbon amount was estimated by thematic map produced by Emilia Romagna Region (for Plain Scale 1:500.000 with grid of 500x500 meters, for Appennines areas scale 1:250.000 with a cells 100x100 meters) (Figure 10, 11).

SOC%	***Project area***	***VT***	***SP***	***TBC***
Maximum	**2.31%**	1.94%	2.31%	2.24%
Minimum	**0.66%**	0.92%	0.66%	0.66%
Average	**1.16%**	1.72%	1.14%	1.01%

Table 9: SOC in PA's vineyards

SOM wes derived using Jackson's equation (Jackson, 1965):
SOM% = 1.724 SOC%

SOM%	***Project area***	***VT***	***SP***	***TBC***
Average	**2.00%**	2.97%	1.97%	1.74%

Table 10: SOM in PA's vineyards

Considering the overall project area, average content of soil organic matter is 2% (Table 9, 10). VT soils are the richest in SOM content.

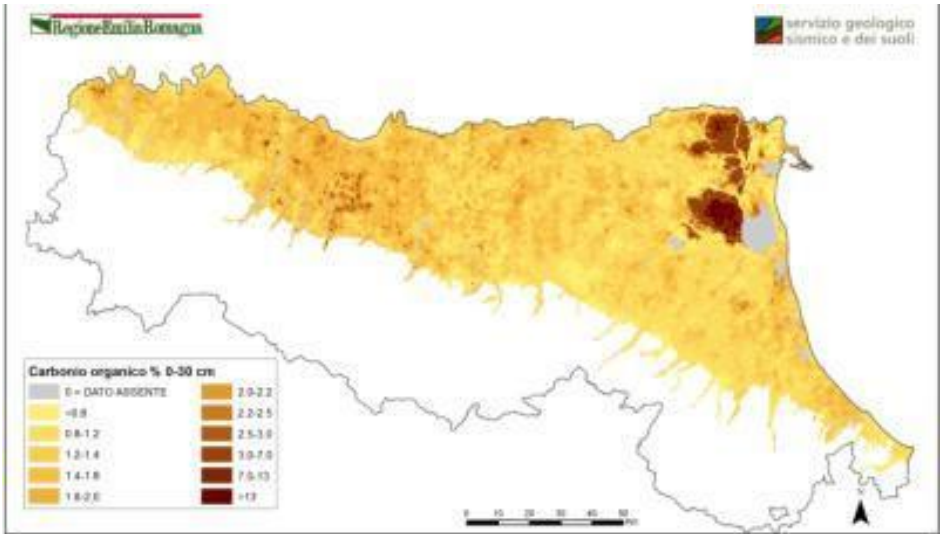

Figure 10: Emilia Romagna SOC% in plain areas (Emilia Romagna Region Soil Service)

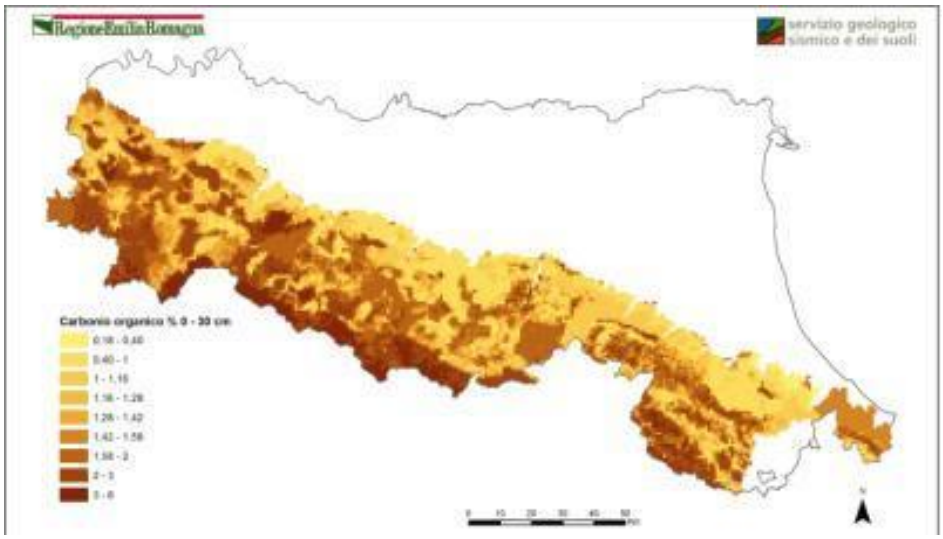

Figure 11: Emilia Romagna SOC% in hills and mountain (Emilia Romagna Region Soil Service)

- ***Floor management***

- Inter-row floor management

During the survey inter-row space was described using three classes of floor management:
- *Spontaneous grass* (Figure 12, 13)
- *Sown cover crops*
- *Bare soil* (Figure 14)

Sometimes inter-row soil coverage is not uniform and, also in presence of spontaneous grass there are large areas of bare soil, mainly subjected to erosion.

Sub-area	***n.vineyards***	***Spontaneous grass***	***Sown grass/cover crop***	***Bare soil***
SP	90	83.0%	1.1%	44.4%
TBC	22	72.7%	0.0%	50.0%
VT	12	91.7%	8.3%	16.7%

Table 11: Inter-row floor management in Project Area

The most frequent floor management technique in the surveyed vineyards (Table 11) is spontaneous grassing: spontaneous grass is present mostly in moderately steep (50.98%) and rolling (25.49%) vineyards, while sown cover crop between row, in particular *Vicia faba minor* L., has been surveyed in only 2 vineyards with slope between 25.64% and 15.46%. No seed grass has been surveyed.
Vine-growers have reported that grassing is an optimal and user-friendly agronomical practice especially in vineyards with high slope, in that it allows to reduce soil erosion and facilitates vineyard's operations.
In the majority of vineyards grass covering is not homogeneous along the row due to erosion, especially with high slopes.
Several vine-growers have reported that they till inter-row space, in the end of spring, also in grassed vineyards in order to enhance water absorption and reduce water competition toward the vines; so grass cannot be considered permanent, rather it is like an annual crop. Number of grass cuttings depends on seasonal trend.

Figure 12: Inter-row grass in vineyard n. 76 and 105

Figure 13: : Inter-row grass in vineyard n. 21 and 108

Figure 14: Inter-row bare soil floor management in vineyard n.12

- Under- the- row floor management

During survey in the row space was described using two classes of floor management:
- *Spontaneous grass*
- *bare soil*

In majority of vineyards herbicides are sprayed along the rows and the dried weeds are still present under the vine row (Table 12).

Sub-area	***n.vineyards***	***Sponteneous grass***	***Bare soil***
SP	90	58.89%	63.3%
TBC	22	81.8%	31.8%
VT	12	91.7%	8.3%

Table 12: Row floor management in Project area

- Headland floor management

During the survey headland space was described using two classes of floor management:
- *Spontaneous grass*
- *bare soil*

Service areas usually present mixed floor management, grass on the border and bare soil in areas used for tractor passage. (Table 13)

Sub-area	***n.vineyards***	***Sponteneous grass***	***Bare soil***
SP	90	76.7%	63.3%
TBC	22	86.4%	31.8%
VT	12	83.3%	8.3%

Table 13: Headland floor management

- ***Assessment of main soil threats***

Visual assessment of soil threats was firstly based on the identification of 5 main threats:
- *erosion*
- *compaction of soil due to tractor passage*
- *presence of stone*
- *grooves*
- *slots*

After a first classification, evaluation of intensity of the above-cited features was performed through VSA.

Erosion

Erosion was classified based of FAO VSA guidelines (FAO, 2008) using four classes of intensity.

0	No erosion
1	Little evidence of soil erosion.
2	Moderate evidence of soil erosion. Presence of small groove and gullies.
3	Deep groove and gullies and visible movement of soil

Localization of erosion phenomena was registered as:
- *only in the vineyard inter-row*
- *in vineyard inter-row and under the vine*
- *only in headlands*
- *in the whole vineyard*

	Project area	***VT***	***SP***	***TBC***
vineyard inter-row	1.16	0	1.08	1.33
vineyard inter-row and under the vine	1.31	0	1.36	1.21
only in headlands	1.73	1.66	1.75	0.77
whole vineyard	1.75	1.28	1.83	1.25

Table 14: Average erosion intensity value

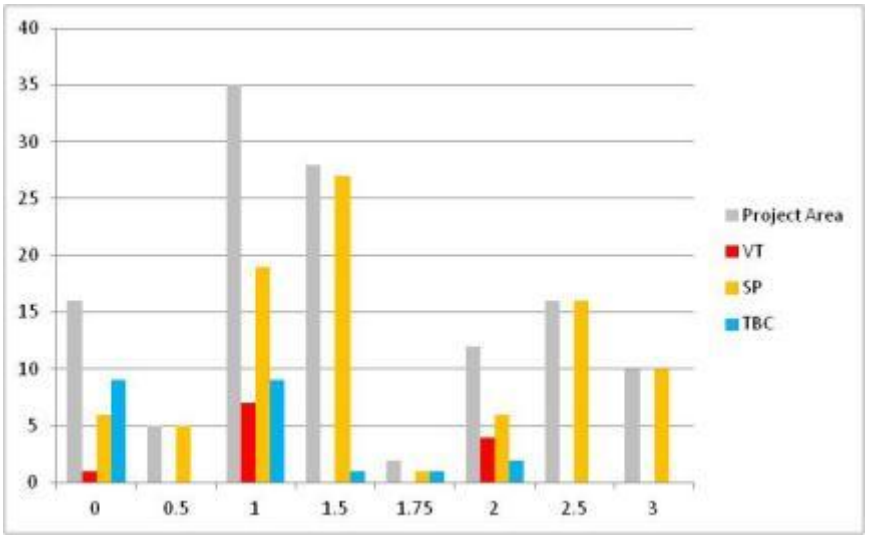

Figure 15: Distribution of vineyard in erosion intensity classes

Erosion intensity (Table 14) involves in general the whole vineyard ecosystem but it is possible to state that headlands are subjected to higher erosion (Figure 15) and surrounding vineyard spaces (wood, banks, street edges) are usually subjected to intense erosive phenomena too (Figure 16, 17).

Figure 16: Erosion in vineyards n. 43 and 60

Figure 17: Erosion in bank near vineyard n.4

Considering the whole vineyard, erosion intensity is higher in SP areas, usually characterized by higher slopes. Analyzing single registered values, highest values (2.5 and 3) were scored in the SP area of 26 vineyards (20.97%) (Figure 18, 19).

Figure 18: Erosion in vineyard n. 33 and 69

Figure 19: Erosion in vineyard n. 75 and 95

Compaction of soil due to tractor passage

Data reported (Table 15) that compaction in the headland and inter-row is mainly in moderately steep vineyards (41.18%) and analyzing the distribution of problem in sub-areas confirm that higher slope are correlated with this limitation. (Figure 20)

	Project area	***VT***	***SP***	***TBC***
Flat	3.92%	0.00%	4.35%	0.00%
Gently undulating	13.73%	0.00%	15.22%	0.00%
Undulating	9.80%	0.00%	10.87%	0.00%
Rolling	27.45%	33.33%	26.09%	50.00%
Moderately steep	41.18%	66.67%	39.13%	50.00%
Steep	3.92%	0.00%	4.35%	0.00%

Table 15: Distribution of compaction in Slope Classes

Figure 20: Compaction of soil in vineyards n.55, 80 and 113

Crust

0	No crust
1	Little crust ease to break
2	Hard crust
3	Very hard crust. Breaking only with specific instrument.

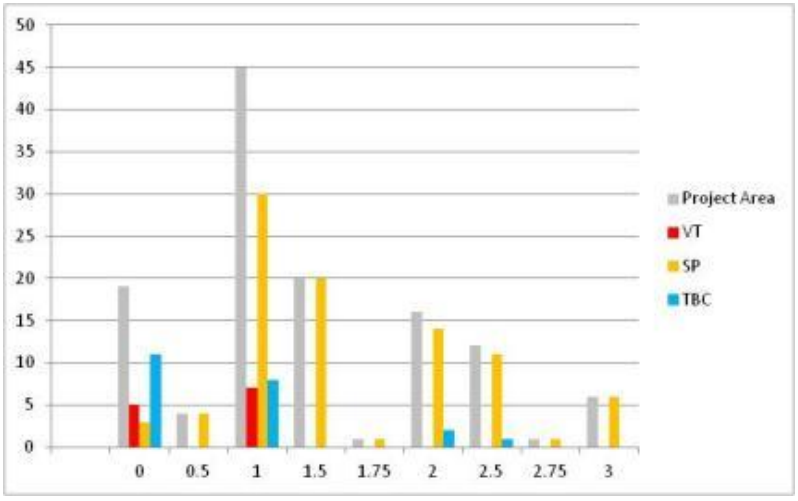

Figure 21: crust intensity

Data reported that average value of crust intensity is 1.30 and the highest values are localized mostly in SP where 19 vineyards (20% of total vineyard in SP areas) score a value above 2 (Figure 21 and 22).
Considering that surveys were conducted after winter season, visual assessment didn't consider crusting as a soil limitation in whole project area but only a problem of SP vineyards characterized by higher value of clay. Wine-growers interviews reported crusting as a limitation especially during dry summer.

Figure 22: Soil crust in vineyard n.60

Stone abundance

0	No stone
1	Scarce
2	Moderate
3	Abundant

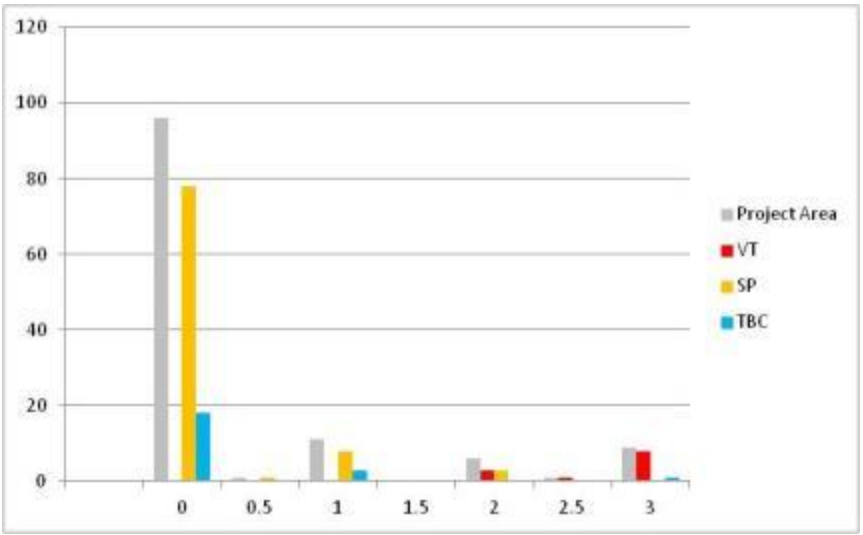

Figure 23: Stone abundance

Figure 24: Stone in vineyard n.24

Figure 23 and 24 show the distribution of stone intensity in the project area and it is clear that the majority of vineyards do not present this kind of limitation. Highest value were registered in VT vineyard's.

Spring water logging

Spring water logging was reported in 23 vineyards and mostly located in the bottom part of fields having moderately steep (47.83%) and rolling (30.43%) areas (Table 16).

	Project area
Flat	0.00%
Gently undulating	8.70%
Undulating	4.35%
Rolling	30.43%
Moderately steep	47.83%
Steep	8.70%

Table 16: Distribution of spring water logging in slope classes

Other problems

Vine-growers have reported severe problems with boars devastating soil structure and damaging grapes (before harvest).
Another reported problem is the presence of wood edges near vineyards with aggressive species such as *Robinia pseudoacacia* whose roots create problem to vines.
Moreover the abandoning of vineyards by neighbours might create problems of water and weeds management.

6. Photographic vineyards Database

During the survey photos have been taken of all vineyards and are attached as additional material to this report.

7. Conclusions

Survey of vineyards in the project area have allowed the identification of main problems affecting soil health and fertility.
Analysis of outcomes of survey show that "slope" can be identified as a main soil threat in the Project Area, causing erosion phenomena and organic matter loss. Erosion usually embraces the whole vineyard ecosystem, including areas near the cultivated land. Headlands are strongly subjected to erosion and compaction.
Abandonment of arable lands and orchard cause problems of water management to still-working farms.
Water management is also a threat under two points of view:
- "water logging" that was reported as a frequent soil threat in high slope vineyards, especially during rainy seasons.
- "water stress" causing problems to soils and vines.
Some growers have already adopted solutions aiming at to reducing soil loss and water run-off; however grass covering is often not uniform and, also in grassed spontaneous vineyards tillage is used performed at least one time per year.
During survey it was clear that wine growers experience and hystorical memory and visual assessment cannot explain all the soil threats and more specifically and analytical soil analysis will be necessary. Thus, more detailed assessments will be made in the Project DEMO farms (that are representative of Project Area farms) during project next actions.

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9. List of Figures

Figure 1: Stirone Piacenziano landscape and badlands 4
Figure 2: Vineyards localization in Google Earth (general overview and detail) 6
Figure 3: Vineyards localization in the Project Area 7
Figure 4: Distribution of Age classes in slope classes 8
Figure 5:Variation of trunk circumference (cm) with progressive vineyard age increase. Vertical bars represent standard error (SE) around the mean 8
Figure 6: Distribution of Density classes in slope classes 9
Figure 7: Drainage in vineyard n.80 10
Figure 8: Vineyard n.30 (Slope: 31.92%) and 86 (Slope: 35.15%) 11
Figure 9: Aspect of vineyards in the Project Area 12
Figure 10: Emilia Romagna SOC% in plain areas (Emilia Romagna Region Soil Service) 13
Figure 11: Emilia Romagna SOC% in hills and mountain (Emilia Romagna Region Soil Service) 14
Figure 12: Inter-row grass in vineyard n. 76 and 105 15
Figure 13: Inter-row grass in vineyard n. 21 and 108 15
Figure 14: Inter-row bare soil floor management in vineyard n.12 15
Figure 15: Distribution of vineyard in erosion intensity classes 17
Figure 16: Erosion in vineyards n. 43 and 60 17
Figure 17: Erosion in bank near vineyard n.4 18
Figure 18: Erosion in vineyard n. 33 and 69 18
Figure 19: Erosion in vineyard n. 75 and 95 18
Figure 20: Compaction of soil in vineyards n.55, 80 and 113 19
Figure 21: Crust intensity 19
Figure 22: Soil crust in vineyard n.60 20
Figure 23: Stone abundance 20
Figure 24: Stone in vineyard n.24 21

9. List of Tables

Table 1: Specific data collected for each assessed vineyard and included in the database 5
Table 2: Distribution of vine density and age classes. 7
Table 3: Distribution of vineyards in Density Classes and Slope classes. 9
Table 4: Elevation of vineyards in project area 10
Table 5: Elevation of vineyards in project area 11
Table 6: Slope Classification (SOTER) 11

Table 7: Distribution of vineyards in Slope Classes 11
Table 8: Soil cartographic units in the vineyards of Project area 12
Table 9: SOC in PA's vineyards 13
Table 10: SOM in PA's vineyards 13
Table 11: Inter-row floor management in Project Area 14
Table 12: Row floor management in Project area 16
Table 13: Headland floor management 16
Table 14: Average erosion intensity value 17
Table 15: Distribution of compaction in Slope Classes 19
Table 16: Distribution of spring water logging in slope classes 21