

## VULNERABILITY OF VINEYARD SOILS TO COMPACTION: THE CASE STUDY OF DOC PIAVE (VENETO REGION, ITALY)

**S. Piccolo<sup>(1)</sup>, M. Bertaggia<sup>(1)</sup>, G. Concheri<sup>(1)</sup>, I. Vinci<sup>(2)</sup>**

<sup>1</sup> Padua University - Department of Agricultural Biotechnology  
Viale dell'Università 16 – 35020 Legnaro (PD) – Italy

[sabrina.piccolo@unipd.it](mailto:sabrina.piccolo@unipd.it)   [marco.bertaggia@studenti.unipd.it](mailto:marco.bertaggia@studenti.unipd.it)   [giuseppe.concheri@unipd.it](mailto:giuseppe.concheri@unipd.it)

<sup>2</sup> ARPAV – Regional Agency for Environmental Prevention and Protection – Regional Soil Observatory

Via S. Barbara 5/A – 31100 Treviso – Italy

[ivinci@arpa.veneto.it](mailto:ivinci@arpa.veneto.it)

### ABSTRACT

The objective of this work is to study the vulnerability of vineyard soil to compaction.

The process of soil compaction represents one of the eight threats to soil identified by European Commission.

It is important to know which soil is susceptible to compaction in order to be able to apply proper soil use and cultivation and to prevent real compaction. From this point of view, the evaluation of soil susceptibility to compaction on European level was done.

The DOC Piave area has been chosen for this study because it is one the most important of the north Italy and involves a great variety of soils.

The model used considers as significant factors drainage, surface organic carbon content and texture. It results that soils with low organic carbon content, medium fine or fine and moderately well drained to very poorly drained have high vulnerability to compaction.

A large part of the vineyard soil of the DOC Piave area has at least moderate vulnerability to compaction.

### KEYWORD

vulnerability – compaction – vineyard – organic carbon – texture – drainage

### INTRODUCTION

Compaction can be defined as compression from an applied force that rearranges and destroys aggregates, increasing bulk density and reducing porosity. It produces meaningful changes in structural properties, in soil behaviour, in the hydraulic and thermal conductivity.

It causes a greater mechanical resistance to radical growth and deepening, a reduction of porosity, with consequent conditions of asphyxia. This can slow down the development of the plants, with negative effects on the productivity of the agricultural cultivations and it can reduce water infiltration in the ground.

Soil compaction results from the combination of natural forces and man induced forces.

Compaction depends on the used farm machineries and on the soil's water content at the moment of passage of the machine.

This phenomenon was studied in the DOC Piave area, in the Veneto region (Fig. 1), one of the most extensive DOC areas of the north Italy (ESAV, 1996) and one of the most national

productive DOC areas in terms of hectolitres produced (134,228 hl in 2007) (Consortium for Piave Wines Protection). The DOC Piave lies in the provinces of Treviso and Venice but Treviso is predominant with 12,700 ha, of which 4,327 ha of vineyard (website Veneto Region).

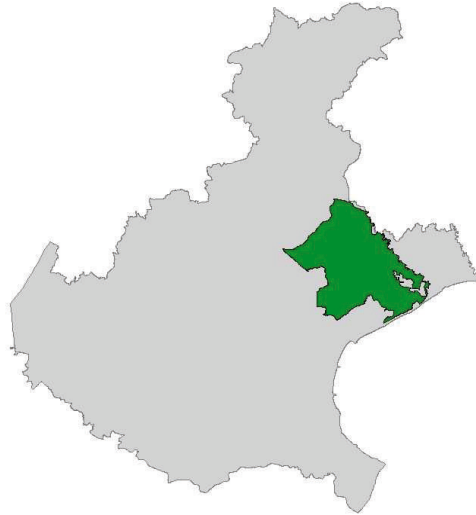


Figure 1. The DOC Piave area in the Veneto region.

#### **MATERIALS AND METHODS**

The basis for this work has been the Soil Map of the Province of Treviso (ARPAV, 2008).

This soil map is structured in four hierarchical levels: district, landscape over-unit (soil system), landscape unit and cartographic unit. Districts are distinguished on the basis of large geographical areas and afferent river basins. Soil systems are identified according to the genetic processes that have carried to the formation of the different surfaces and to the age at which these processes have finished. Soil systems for the plain are differentiated on the basis of the morphology and the texture of the parental material (sand, silt and clay) while for the mountain the dominant factor is the morphology. The soil systems of the DOC Piave area are represented in figure 2.

Landscape units identify different shapes on the land (levee, depression and modal plain).

In every landscape unit there are cartographic units, homogeneous areas characterized by the same soil set. Every cartographic unit has one or two predominant soil type, soil typologic unit (UTS), a soil group with similar features and organization in horizons.

In this study the predominant soil typologic unit in the cartographic unit has been chosen. The UTS, in which land use includes vineyard soil, have been selected. So only the cartographic units with vineyard soils are represented in this work and, as consequence, a wide part of the DOC Piave area isn't embodied, especially that in province of Venice.

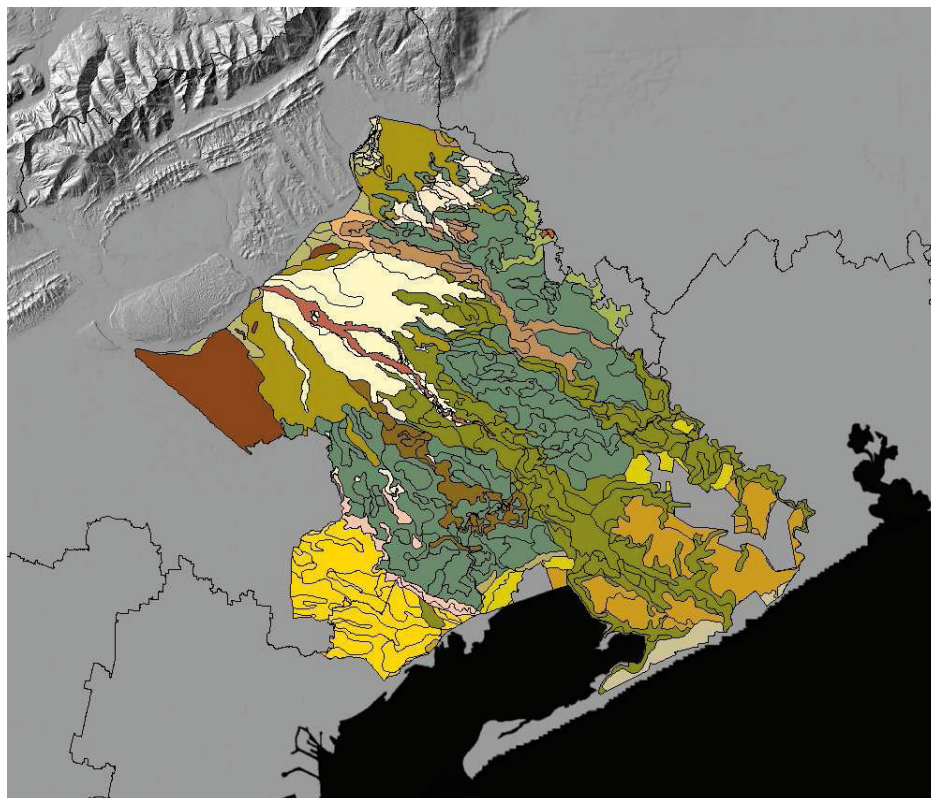


Figure 2. Soil systems in the DOC Piave area.

The model used in this study (Agriculture and Agri-Food Canada, adapted from Martin and Nolin, 1991) considers three soil characteristics: organic carbon (C.O.) content of A horizon, surface layer texture and drainage class (Tab. 1).

The A horizon is the top layer of a soil profile, also called topsoil; it may be darker in colour than deeper layers because of the greater organic material content or lighter because contains less clay or sesquioxides.

Soil vulnerability to compaction is the probability that soil becomes compacted when exposed to compaction risk. It can be nil to low, moderate or high (Tab. 2).

Table 1. Organic carbon content, texture (Agriculture Canada, 1976) and drainage classes

C.O. content	of A horizon	DRAINAGE	TEXTURE	class of	A horizon
Low	< 1.7%	Very rapidly drained	1	Coarse	Sand, loamy sand
Moderate	1.7 – 4%	Well-drained	2	Medium coarse	Sandy loam
High	4 – 9%	Moderately well-drained	3	Medium	Loam, silt loam, silt
Very high	9 – 17%	Imperfectly drained	4	Medium fine	Sandy clay loam, clay loam, silty clay loam
		Poorly drained	5	Fine	Sandy clay, clay, silty clay
		Very poorly drained	P	Peaty	≥ 17% C.O.

Table 2. Soil compaction vulnerability assessment model

<b>Drenaggio</b>					
Very rapidly drained to well drained	Nil to low				
	<b>Organic soils</b>				
Moderately well drained to imperfectly drained	Peaty	Nil to low			
Poorly to very poorly drained	Peaty (fibric and mesic)	Nil to low			
Very poorly drained	Peaty (humic)	Moderate			
	<b>Mineral soils</b>	<b>C.O. content of A horizon</b>			
	<b>Texture class of A horizon</b>	<i>Low</i>	<i>Moderate</i>	<i>High</i>	<i>Very high</i>
Moderately well to imperfectly drained	1 and 2	Nil to low			
	3	Moderate	Nil to low	Nil to low	Nil to low
	4 and 5	High	Moderate	Nil to low	Nil to low
Poorly to very poorly drained	1 and 2	Moderate	Nil to low	Nil to low	Nil to low
	3	High	Moderate	Nil to low	Nil to low
	4 and 5	High	High	Moderate	Nil to low

Data concerning soil have been taken from the soil map of the province of Treviso, carried out by Regional Soil Observatory of Treviso. It carefully describes cartographic units with its prevalent UTS. In the explanation of the soil typologic unit, land use, drainage and the horizons with all the characteristic, texture and C.O. content are reported.

## RESULTS AND DISCUSSION

Applying the table 2, it results that soils with low C.O. content (< 1.7%), fine or medium fine (clay soils) in the surface horizon, moderately well-drained or imperfectly drained and loam soils with low organic carbon content poorly drained have a high vulnerability to compaction. Whereas soils with moderate held in C.O. (1.7 – 4%), fine, moderately well-drained and loam poorly drained have a moderate vulnerability. Generally grounds with high organic carbon content (> 4%) have vulnerability nil to low.

In the DOC Piave area, the most vulnerable zones are localized in three zone: one south east of Treviso, from Silea to Roncade, one in the centre, in the east of Oderzo, between Ponte di Piave and Salgareda and another one from Gaiarine to Motta di Livenza (Fig. 3).

Highly vulnerable soils are these:

- **soils of the ancient low plain of the Piave river:** soils Marteggia and San Fior, silty clay loam, with mediocre drainage, soils Lutrano and Borin, silty clay and soils Olmi, silty clay loam, imperfectly to poorly drained;
- **soils of the ancient low plain of the Tagliamento river:** soils Cinto Caomaggiore, silty clay, poorly drained;
- **soils of the recent plain of the Monticano and the Meschio rivers:** soils Termen, silty clay, poorly drained;
- **hydromorphic soils of spring lowlands:** soils Meolo and Biancade, of the reclaimed wetlands, silty clay loam, poorly drained.

All these soils have a moderated C.O. content in the surface layer.

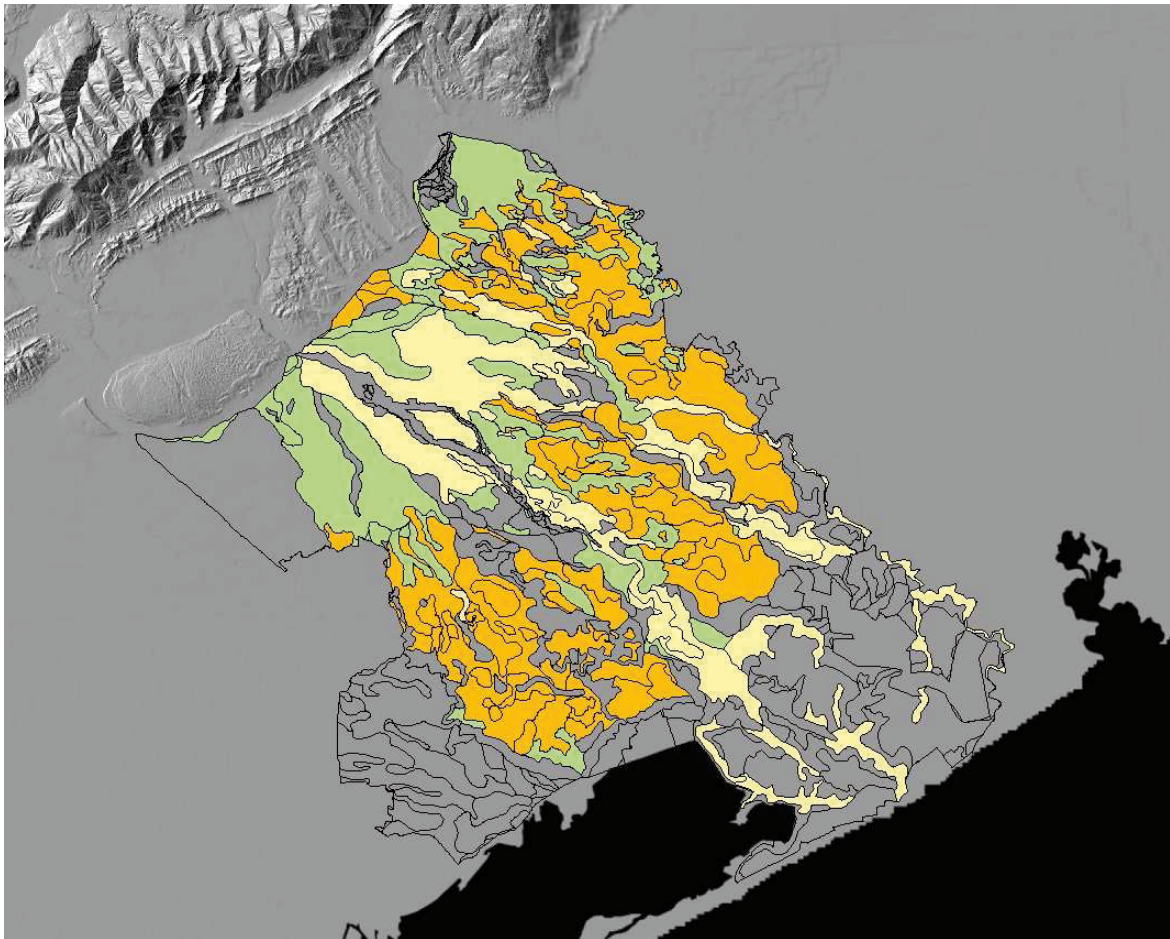
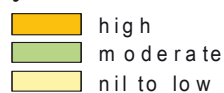


Figure 3. Vulnerability of vineyard soils to compaction in the DOC Piave area.





## CONCLUSIONS

There are a lot of vineyard soils that have low C.O. content, fine or medium fine texture in the surface, moderately well-drained or loam soils with low organic carbon content, poorly drained and so they are very vulnerable to compaction.

In fact, the major part of the vineyard soil of the DOC Piave area (about 44% of the cartographic units) has moderate vulnerability, about 33% high and the rest (23%) nil to low.

This means that nearly the 80% of vineyard soils has at least moderate vulnerability to compaction, so in these soils we have to adopt appropriate tillage techniques and adequate soil management to preserve the land and to maintain the crop yield.

To reduce compaction levels, the best method is increasing organic matter levels: this maximizes the aggregation of soil particles and consequently increases soil stability. In addition, rotation crops provide a variety of root types and patterns in the soil that break up compacted layers.

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## BIBLIOGRAPHY

Agriculture Canada, 1976. Glossary of terms in soil science. Canada Department of Agriculture, Publication 1459. Ottawa: Information Canada.

ARPAV, 2008. Carta dei suoli della provincia di Treviso. Castelfranco Veneto (TV).

ARPAV, 2005. Carta dei suoli del Veneto. Castelfranco Veneto (TV).

Regione del Veneto, ESAV, 1996. I suoli dell'area a DOC del Piave - Provincia di Treviso. Serie pedologica 2.

## Websites

Agriculture and Agri-Food Canada: <http://www.agr.gc.ca>

Veneto Region: <http://www.regione.veneto.it/MondoAgricolo/NewsView.aspx?idNews=1185>

Veneto Agricoltura: <http://www.venetoagricoltura.it/basic.php?ID=1955>