

Long-term monitoring of soil management effects on runoff and soil erosion in sloping vineyards in Alto Monferrato (North–West Italy)



Marcella Biddoccu^{a,b,*}, Stefano Ferraris^b, Francesca Opsi^a, Eugenio Cavallo^a

^a Institute for Agricultural and Earthmoving Machines (IMAMOTER), National Research Council of Italy (CNR), 10135 Torino, Strada delle Cacce, 73, Italy

^b Interuniversity Department of Regional and Urban Studies and Planning (DIST), Politecnico di Torino and Università di Torino, 10125 Torino, Castello del Valentino, viale Mattioli, 39, Italy

ARTICLE INFO

Article history:

Received 18 December 2014

Received in revised form 10 July 2015

Accepted 13 July 2015

Keywords:

Soil management

Vineyards

Runoff

Soil erosion

Soil compaction

Database

ABSTRACT

Long-term runoff and soil erosion data have been collected from differently managed field-scale vineyard plots within the “Tenuta Cannona Experimental Vine and Wine Center of Regione Piemonte”, located in the Alto Monferrato vine production area (NW Italy). The primary intent of the program was to evaluate the effects of agricultural management practices on the hydrologic, soil erosion, nutrient transport and soil compaction processes in vineyards. Field runoff data have been collected for every event since the year 2000 until now. Sediment and nutrient concentrations in water have been also monitored. Regarding soil properties and initial conditions, surveys have been carried out to investigate spatial and temporal variability of soil bulk density, soil saturated conductivity, soil water content, and penetration resistance. The Cannona Data Base (CDB) includes data for more than 300 runoff events and over 90 soil loss events; moreover, periodic measurements for soil physical characteristics are included for the three plots.

Runoff and sediment yield showed high annual and seasonal variability and were strongly affected by the adoption of different soil management in the vineyard inter-rows, especially after some years of observation. Grass cover reduced runoff by at least 37%, in comparison with management by tillage, and average annual sediment yield ranged from 1.8 Mg ha⁻¹ year⁻¹ to 20.7 Mg ha⁻¹ year⁻¹, respectively for the “grass covered” and the “reduced tillage” vineyards. Furthermore, results showed the effect of the adopted soil management on soil properties. The Cannona Data base (CDB) can be accessed via a website (<http://sustag.to.cnr.it/index.php/cannona-db>) supported by the IMAMOTER-CNR.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

Piemonte, NW Italy, is a long established and specialized wine region and produces some of the best-known, top quality Italian wines (e.g., Asti Spumante, Barolo, Barbera) and it is the second largest (after Veneto) Italian wine exporting region. In Piemonte the vine growing and oenological industry greatly contribute to the agricultural income and vineyards cover more than 52,000 ha, accounting for around to 7.3% of the Italian wine production area (725,267 ha) (ISTAT, 2014). According to the agricultural statistical database of the Piemonte Regional Administration (Regione Piemonte, 2014a), more than 95% of the vineyard surface of the region is on hilly area and near 1% on mountain area, and the vineyards are concentrated in the southern part of the region, in the hilly territory Provinces of Asti, Cuneo and Alessandria. Hilly

vineyards are easily subject to soil erosion, depending on the adopted soil management system. Water and soil protection are key issues for European countries, as the European Commission demonstrated by adopting the Water Framework Directive in 2000 (Directive 2000/60/EC) and the Soil Thematic Strategy in 2006 (CEC, 2006a,b). Erosion has been identified as one of the major threats that affect European agricultural soils. An estimated 12% of Europe's total land area is subject to water erosion. Cerdan et al. (2010) estimated a mean erosion rate of 2.3 t ha⁻¹ year⁻¹ for Italy, corresponding to 12.5% of the total European erosion. They predicted the highest erosion rates in vineyards and arable lands. Measured data (Maetens et al., 2012) showed that in the Mediterranean region runoff rates higher than 9% are related to vineyard land use. Among agricultural uses only tree crops showed higher runoff rates in the same region. More than 50% of the hills of the Piemonte region (NW Italy) is characterized by soils with moderately high or high erodibility, with values of the RUSLE K-factor (Wischmeier and Smith, 1978) higher than 0.047 Mg ha h ha⁻¹ MJ⁻¹ mm⁻¹ (IPLA, 2007; van der Knijff et al., 2000). In

* Corresponding author.

E-mail address: m.biddoccu@ima.to.cnr.it (M. Biddoccu).

Piemonte, Tropeano (1984) ran the first soil erosion measurements in vineyards in the 1980's, for about 2 years. In some vineyards located in the Alto Monferrato area, Tropeano measured soil losses ranging from 0.2 Mg ha^{-1} , in a vineyard where dry agents were used in no-tilled inter-rows, to 47.4 Mg ha^{-1} in a deeply plowed vineyard. In 2007 the Regional Rural Development program introduced environmental payments to encourage the adoption of best soil management practices, i.e., the use of grass cover in vineyards and orchards in order to protect soil from degradation. In recent years several studies have been carried out across Europe in order to evaluate the effect of vineyard's soil management on water and soil losses, with measurements both under simulated (Arnaez et al., 2007; Blavet et al., 2009) and under natural rainfall (Raclot et al., 2009; Novara et al., 2011; Ruiz-Colmenero et al., 2011). Experiments under natural rainfall are usually based on data collected during a monitoring period ranging from two to five years. Data collection on a wider temporal scale allow a better assessment of the temporal variability of water and soil losses. In fact, hydrological and soil erosion response can be very different from one year to another one (Casalí et al., 2008), and with the exception of extraordinary erosive rainfall events, erosion shows visible effects only after a few years. Furthermore, once they are established, vineyards are cultivated for some decades. In order to evaluate the long-term effects of agricultural management practices on the hydrologic system, soil erosion, and soil compaction processes in vineyards, the Institute for Agricultural and Earthmoving Machines (IMAMOTER) of the National Research Council of Italy (CNR) initiated a research program in the "Tenuta Cannona Experimental Vine and Wine Center of Regione Piemonte" (Tenuta Cannona Center) in 2000, with support of the Office for Agricultural Development of Regione Piemonte. The experiment consists of monitoring natural rainfall events producing runoff and erosion on three field-size vineyard plots with different soil management. In addition, recurrent measurements have been carried out to investigate spatial and temporal variability of the soil bulk density, soil water content, and penetration resistance. The Cannona Erosion Plots are representative of a real vineyard, since every plot is a hillslope portion of a vineyard field, that is managed according to traditional farming

practices, with different inter-row's soil management. Data from 10 years of observation were analyzed and previously reported in order to evaluate the effect of soil management and seasons on runoff and soil erosion processes in sloping vineyards (Corti et al., 2011; Biddoccu et al., 2013; Biddoccu et al., 2014). The monitoring activities at the Tenuta Cannona Experimental Center are currently carried out and implemented in order to improve the understanding of the soil management effects on soil hydrology, erosion, and compaction in sloping vineyards. Other natural processes are strictly related to the hydrologic behavior of the soil that drives infiltration, runoff formation on slopes, soil erosion, and the consequent sediment delivery to water courses. Costantini and Lorenzetti (2013) underlined the need of better understanding of soil degradation processes in a multi-disciplinary approach, with particular regard to Italy, due to the great variability of environmental conditions.

The aim of this paper is to provide a description of the Tenuta Cannona Erosion Plots and of the Cannona Data Base (CDB), and to present the main results of the 14-years runoff and sediment losses monitoring. The CDB represents a data collection which is unique in Italy for vineyards, showing the long-term response of soil to natural rainfall in terms of runoff and soil erosion during more than a decade of experimentation. It includes data for more than 300 runoff events and over 90 soil loss events, and data of some soil physical characteristics monitored in the plots. Instrumentation and methods used in data collection and analysis are described in the following paragraphs. The CDB is available on a website supported by the CNR, for water and land management researchers and professionals. Data from the CDB are available to calibrate and validate both runoff and soil erosion models. Also, it allows to investigate the interactions between land use, soil management, and natural processes at different scales.

2. Methodology

2.1. Site description

The "Tenuta Cannona Experimental Vine and Wine Center of Regione Piemonte"; ($44^{\circ}40'N$, $8^{\circ}37'E$, 296 m asl) is located in the

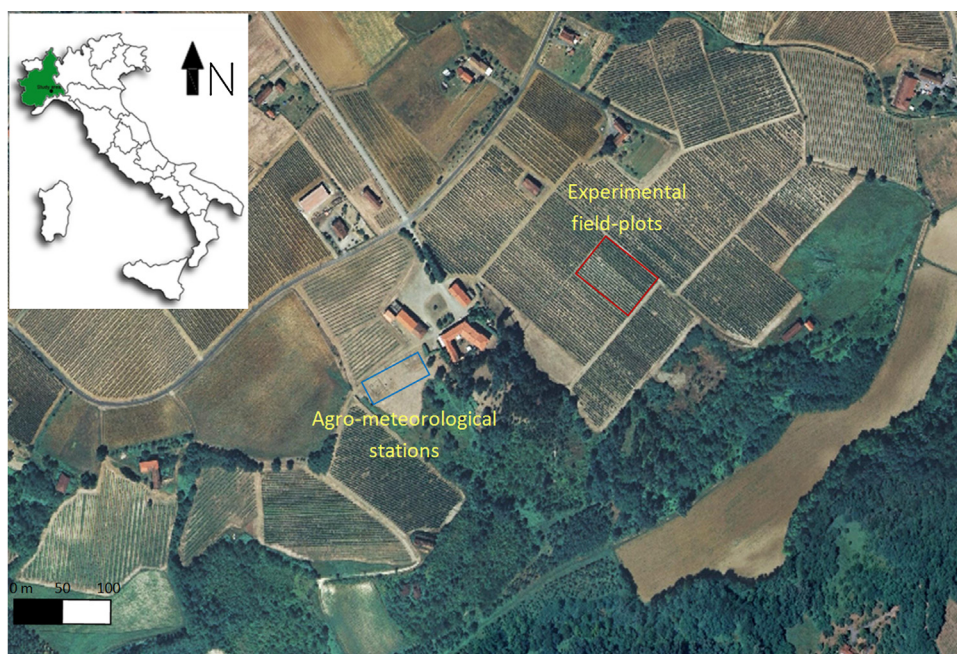


Fig. 1. Location of the Tenuta Cannona Experimental Center. Rectangles show the experimental field plots and of the Agro-meteorological station.

Download English Version:

<https://daneshyari.com/en/article/305474>

Download Persian Version:

<https://daneshyari.com/article/305474>

[Daneshyari.com](https://daneshyari.com)