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Organic farm does not improve neither soil, or water quality in rural watersheds from southeastern Brazil

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ABSTRACT

This study was conducted in a rural region where there are conventional and organic farms, the agricultural production includes more than 20 million people, and the effect on environmental quality is still poorly known in terms of indicators. Our objectives were: (1) compare soils attributes to reference areas, (2) verifying if cultivated areas under different farm systems presented differences in the soils attributes, (3) evaluate the attributes of quality water of watersheds and comparing the results with limiting values established by environmental legislation, and (4) analyze the values considering three criterion: watersheds, climatic season, and region of the landscapes. The study was conducted in two rural watersheds that have similar biophysical features and located in the Ibiúna municipality, São Paulo State, Brazil. However, one watershed encompasses farms where landowners largely use conventional agricultural systems. In the other watershed approximately 25% of the farms there are using an organic farm system. In the two watersheds soil samples were collected in sites covered with natural forest and in sites with agriculture (one watershed being organic and other being conventional). The attributes analyzed were soil bulk density (BD), concentrations of Carbon (C) and Nitrogen (N), C:N ratio, C Management Index, and the abundance of ^{13}C and ^{15}N in the soil organic matter. Water attributes were analyzed onsite or in laboratory after analysis of samples. Analyses included: air and water temperature, pH, dissolved oxygen, salinity, total of dissolved solids, total solids, electric conductivity, turbidity, total chloride, nitrate, total phosphorus and potassium. Regarding the soil attributes our database revealed that (1) the soils from cultivated sites of both watersheds presented significant differences from their respective forested areas, (2) Soil attributes are of equal quality in both farm systems. Concerning water attributes: (1) almost all attributes presented values better than the limiting values stipulated by Brazilian legislation; (2) the watersheds did not present significant differences of most of the attributes; (3) in the criteria climatic season data showed some significant differences. The data showed that the soils from the areas used for agricultural ends present belief that significantly worse soil quality in comparison to soils from sites still covered with natural forest. Neither the land cover nor farming system are altering the superficial water quality of the studied watershed and this appears to be related to the extensive percentage of natural remaining vegetation that still exists in both watersheds. The seasonality is an important force that drives the quality characteristics of the water. We highlight that the principles of organic agriculture should be practiced more efficiently and influences such as deforestation should be rigorously avoided.

1. Introduction

Integrated assessment of natural resources is of paramount importance anyplace worldwide, once human well-being depends on the quality of natural resources (UNEP (United Nations

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Environmental Program), 2011). It is highly important in establishing strong and coherent institutional arrangements that are needed to ensure the efficient collection, storage, analysis and summary of data and the availability of data, for instance of soil and water quality, to potential users. One of the difficulties in carry out integrated studies is due the existence of interaction and response in multiple scales within and between natural subsystems (Sykes et al., 2001). Consequently, studies integrating databases regarding soil and water have not been so common. The accomplishments of a watershed management programs are dependent on survey data and analysis in the different compartments and verification of the influence among each other.

In the Brazilian southeastern region we have the Ibiúna municipality, sited approximately 80 km west far from São Paulo Capital City. Ibiúna is an important tourist region and also encompasses important areas used for agriculture. The São Paulo's metropolitan region encompasses the Capital City São Paulo and also 38 municipalities, and has a population of approximately 21 million people. This region is the main consumer center of most of the agricultural products produced in Ibiúna. In Ibiúna there are two adjacent watersheds that jointly constitute an interesting scenario for conducting a comparative analysis of attributes of soil and water, because on the one hand, such watersheds have similar natural characteristics among them, and the other hand, in one of the watersheds organic farming is practiced there, and in the other conventional agriculture is practiced. Hence, this scenario is suited for developing an integrative study considering responses of the soil and water quality attributes according to land cover and land use.

1.1. Soil and water attributes related with rural land use

Soils play a key role in the definition of sustainable land management since they represent the basis of food production (Fliessbach et al., 2007). A fertile soil provides essential nutrients for crop plant growth, supports a diverse and active biotic community, exhibits a typical soil structure, and allows for undisturbed decomposition of organic materials (Mader et al., 2002). The ecosystem services provided by the soil are usually constituted by a set of chemical, physical and biological attributes and commonly indicate the quality of soil. On its turn, isotopic abundances could be a powerful tool to elucidate differences in ecosystem functioning and driving mechanisms of element cycling in the different land cover situations, like forest-covered and agricultural sites, as well as different land uses, like organic and conventional management systems (Choi et al., 2003; Klaus et al., 2013).

On the other hand, soils exert a fundamental influence on water attributes. How we handle the soil and what we deposit on it determine, in part, the level of treatment required to protect our water supplies. Agriculture is estimated to be responsible for 70% of nitrate and 30–50% of phosphorus pollution (Kay et al., 2012) and the land use is responsible for a major amount of total solids delivered to water bodies (Welch and Jacoby, 2004). This shows why an efficient soil management and planned land cover help protect water quality.

The concept of what is rural has an exceptional range of variations worldwide. In this study, we consider the concept of proposed by Brazilian Institute for Geography and Statistics (www.ibge.gov.br): a rural area is an area that is located externally to a town. In rural areas there are many kinds of land cover, leading to different forms of soil management and with different amounts and intensities of environmental impacts, including loss in quality to both soil and stream water.

1.2. Organic and conventional vegetable farms

Agriculture is a kind of human activity developed to produce goods of value to people. Farmers commonly use a set of approved agronomic practices in order to get the best agricultural yield from the field. Some of the activities include, but is not limited to: genetic melioration of the cultivars, soil management techniques, including several kinds of fertilization and tillage, pest control, water management, among others. Some agronomic practices are included in the concept called "conventional farm system", as the adoption of monocultural agroecosystems, use of several types of pesticides, mineral fertilizers and other practices that admittedly are degrading both for environment and human health. However, it is well known that a large number of farms worldwide are still using this type of farming system.

Conversely, since the last decades, new agronomic practices have been developed, aiming to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings (Naturland, 2014; Seufert et al., 2012). Due to the capacity of producing good crop yields with minimal impacts on environmental features, many people believe that "organic farming systems" that consider different practices and crop rotations and/or use of organic fertilizers in adequate amount and quality might represent a realistic alternative to conventional farming systems (Mäder et al., 2002). However, in several situations, especially in areas where it is not usual to work with consultants, groups of farmers with a commercially interest in cash crops who work without any inputs are certified organic and able to sell for a premium price without signification changes in agricultural practice (Brul, 2012).

Organic agriculture has as one of the principal principles sustaining and improvement of the soil (Naturland, 2014). However, while some analyzes regarding the effectiveness of using organic-based agronomic techniques in order to actually promote environmental ameliorations has generated highly diversified results, where some studies showing effectiveness (Winqvist et al., 2012), and others showing that the performance is not significantly different (Hokazono and Hayashi, 2012). For example, albeit there is some evidence that concentrations of Carbon (C) in the soil are greater in soils managed organically than in those from integrated or conventional farming, other studies have not found such differences (Marinari et al., 2006; Mondelaers et al., 2009; Parras-Alcántara et al., 2014). If soils from organic farms have been practiced on nutrient limited soil they do not respond as strongly as production from irrigation or conventional systems. On the other hand, better water-holding capacity and water infiltration rates have produced greater yields than conventional systems under drought conditions and excessive rainfall (Seufert et al., 2012).

Furthermore, while studies involving soil-related attributes with organic farming systems are abundant, studies relating surface water-related attributes and organic farming systems are less common, especially in Brazil (Takino and Maier, 1997). Some researchers suggest that "organic farmscapes" might reduce the amounts of nitrogen (N) and phosphorus (P) transported from the soil surface due the reduction of volume of runoff, and conversely, environmental problems most commonly found on organic farms result from mismanaging manure applications or soil incorporation of green-manure crops, or from improper storage of manure or compost (Bellows, 2002).

One of the features that is responsible, is the high variability of performance of organic farm systems is regarding the time of adoption of organic-based farm system in the rural property (Marinari et al., 2006; Assis and Romeiro, 2007). Another factor is the differentiated use of organic-based agronomic techniques and organic fertilizers among sites. Because of these inconsistent