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# The contribution of karstic rocks to soil quality, Ioannina plain (Epirus, Hellas)

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ABSTRACT

Soil is a significant link to the food chain as trace elements and compounds are provided, directly or indirectly, to plants, animals and people. In certain areas, soil quality depends mainly on karstic rocks, such as limestone and dolomite, on which a certain type of ecosystem (karst ecosystem), is developed.
Ioannina plateau in NW Hellas constitutes a large karstic basin. According to the analytical results of 112 soil samples from the plain to the north-west of the city of Ioannina, a 100 $km^2$ area, which is part of the same karstic system (polje) there is a sufficient amount of samples with over 4% of $CaCO_3$ in about 23.20% of the sampled area. The highest values of $CaCO_3$, water extractable and exchangeable $Ca^{2+}$ and $Mg^{2+}$ cations, bicarbonate ($HCO_3^-$), Cation Exchange Capacity (CEC), and pH are observed specifically in a NW–SE trending zone near to the foothills of the limestone of Mitsikeli mountain. This is mainly due to the higher supply of material, derived from the dissolution of carbonate rocks, transportation and deposition of $CaCO_3$ of soil originating from the Mitsikeli mountain. The foothills of Mitsikeli mountain are enriched in the detritus derived from the weathering of limestone, and subsequent fluvial erosion and deposition of the calcium carbonate detritus downstream. The transport capacity of the many streams, that drain the slopes of Mitsikeli mountain, is increased, because the inclination is up to 30° and, therefore, with concurrent increase in the supply of such sediments in the eastern part of the Ioannina polje. Thus, the quality of soil in this NW–SE trending zone is definitely improved, mainly because of the supply of calcium carbonate from the aforementioned karst structure, resulting in the development of good quality soil for agricultural use and, consequently, in the development of karst ecosystem.


## 1. Introduction

The long-term development of global socio-economic systems requires the sustainable use of natural resources (Brundtland, 1987; Tóth et al., 2007). According to Tóth et al. (2007) a variety of landscapes, land use traditions, social environments, scientific schools, languages and many other factors, generated a diversity of definitions and understandings of the concept of "soil quality" in Europe. Complex approaches to describe soil (and land) quality through the multifunctional nature of soil (and land) appeared in the second half of the 20th century worldwide, giving the frame for a possible common scientific understanding of the problem. One of the first widely accepted definitions was published by the Food and Agriculture Organisation of the United Nations (F.A.O., 1976) describing land quality as "*a complex attribute of land, which acts in a distinct manner in its influence on the suitability of land for a specific kind of use*".

Soil chemistry has traditionally focused on the chemical reactions in soil that affect plant growth and nutrition (Sparks, 2003). However, at the beginning of 1970s, and certainly in the 1990s, as concerns increased about inorganic and organic contaminants in water and soil and their impact on plant, animal, and human health, the emphasis of soil chemistry is now on environmental soil chemistry (Kabata-Pendias and Pendias, 2001; Reimann et al., 2014a,b). According to Sparks (2003) environmental soil chemistry is the study of chemical reactions between soil and environmentally important plant nutrients, radionuclides, metals, metalloids, and organic chemicals. Soil is a significant link in the food chain as it provides major and trace elements and compounds not only to plants, but to water, animals and people directly or indirectly (Demetriades et al., 2010; Johnson et al., 2011; Kabata-Pendias and Mukherjee, 2007; Kabata-Pendias and Pendias, 2001; Urushibara-Yoshino, 1993). The quality of soil is mainly linked to its mineral composition and the concentration of chemical

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elements and compounds therein (Papadopoulou and Vryniotis, 2007; Papadopoulou-Vrynioti et al., 2013a; 2014; Polyzopoulos, 1976; Sposito, 1983).

The term 'karst ecosystem' is defined as the environment with its living element and the factors that affect it (Neuendorf et al., 2011; Skilodimou et al., 2013). According to Yuan (2001), the karst ecosystem is explained as the ecosystem that is restrained by karst environment, especially, by karst geological setting and how the karst environment affects life (Papadopoulou-Vrynioti et al., 2013b, c; Vreča et al., 2001), and also the reaction of life support systems to the karst environment. The presence of karst rocks affects directly the karst ecosystem (Jianhua et al., 2007; Pfeffer, 2010; Tepsongkroh, 2000), due to its hydrogeological regime (Mertzanis et al., 2005a, b, 2011), which is completely different from other ecosystems in the same climatic zone. Karstic rocks, especially limestone and dolomite, through dissolution, supply soil with the necessary nutrients to improve its quality.

In most regions of Hellas, because of the widespread distribution of limestone and dolomite, soil has high contents of calcite and, consequently calcium, one of the main nutrients for the healthy growth of plants. At several places in Hellas, dolines and poljes (e.g., Kopais plain) occur, and they are suitable for agriculture because of their fertile soil (Papadopoulou-Vrynioti, 1990, 1999, 2004).

This paper's purpose is to examine the quality of soil in the plain to the NW of Ioannina, in relation to the occurrence of karstic rocks in the greater area, and the development of good quality soil for agricultural use and for karst ecosystem (Barany-Kevei, 2000; Jianhua et al., 2007). For this purpose, the concentrations in soil of the following parameters are examined, i.e., $CaCO_3$, water-soluble $Ca^{2+}$, bicarbonate ($HCO_3^-$), exchangeable cations ($Ca^{2+}$, $Mg^{2+}$), and the values of pH and CEC.

## 2. Study area

The area under study is situated to the NW of the city of Ioannina in Epirus of north-western Hellas, and is part of the Ioannina karstic basin (Fig. 1). It is an elongated area of 80 km$^2$ between the mountain range of Mitsikeli to the NE, the intermontane plateau range to the W, the plains of the Protopappas and Petsalion villages to the NW, and the city and lake of Ioannina to the SE towards where the majority of the drainage flows. The altitude of the plain part of the study area, where the soil geochemical survey was carried out (Vryniotis, 2010), varies from 465 m in the area of Lapsista, to 520 m in the SW edges of the area of Rodotopion and the mountain of Marmaras to the west. The Ioannina plain is interrupted by a series of NW–SE trending limestone hills of small extent (Fig. 1), reaching an altitude of up to 758 m, which divide the plain area in two separate zones with the same trend; these limestone hills, because of their small area extent do not appear to affect much the chemical composition of soil in the study area. The eastern part of the plain, directly to the NW of the Ioannina lake basin, has the largest area.

The precipitation as well as temperature variation throughout the year are major factors that affect the physico-chemical processes in the water–soil–fauna–flora system. The climate of the study area is continental, and according to the records of the Hellenic National Meteorological Service, it has an average annual precipitation of

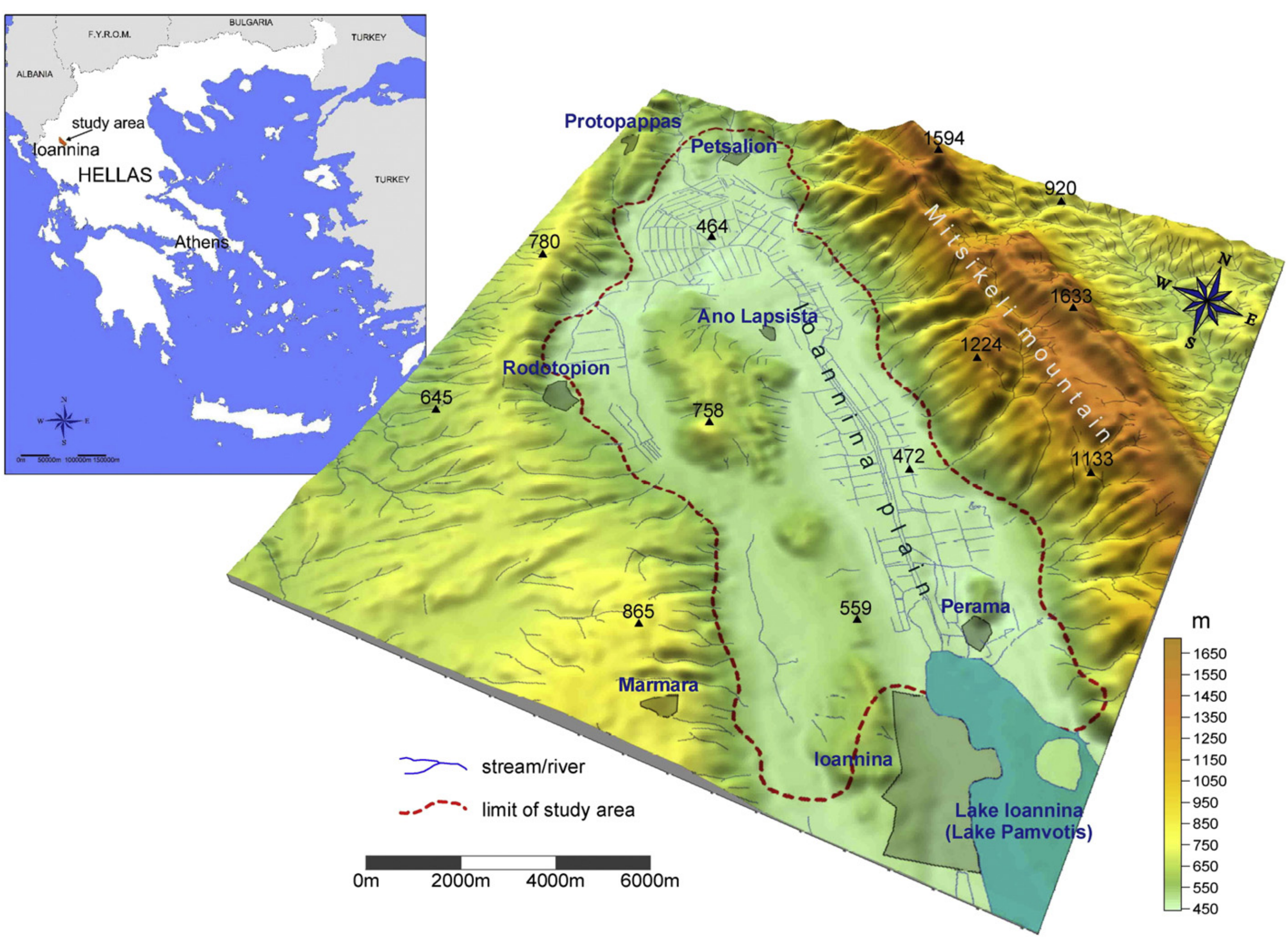


**Fig. 1.** Location map and three-dimensional terrain map of the study area, Ioannina plain, Hellas.