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Soil Organic Carbon in Godech Municipality, Western Bulgaria

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Abstract

The current study aims at examining soil organic carbon levels at the territory of Godech Municipality - one of the municipalities of Sofia Province, located in the western part of Bulgaria. The investigation includes information about some of the latest global studies, regarding soil organic carbon, including those, conducted on Bulgarian territory. Soil organic carbon plays a key role in overall carbon sequestration and it plays a key role for sustainable development. A basis of the study is the investigation of Hengl et al. (2017) who created a global soil grids at 250 m resolution. Their datasets consist of prediction data about carbon contents in g per kg at the following depths: 0 cm, 5 cm, 15 cm, 30 cm, 60 cm, 100 cm and 200 cm. This data is analyzed and developed for the purposes of the current study. Generally, soil organic carbon contents in Godech Municipality decrease from north to south, with the largest carbon pool in Berkvoska Mountain. There is an increase of carbon stocks from subsoil to topsoil, which is consistent with other results. The outcomes of the study prove to be successful and they can be applied in other investigations of this subject.

Keywords: carbon sequestration, soil organic carbon, sustainability

1. Introduction

Investigations, focusing on carbon sequestration, are increasing by the minute. This subject is gaining international recognition and is becoming more and more popular among scientific teams throughout the world. Carbon sequestration is considered as an essential process for climate change mitigation, therefore it is a key element for the promotion of the principles of sustainability. Soil is being acknowledged as the largest terrestrial carbon pool by various authors, including Stockmann et al. (2013), Scharlemann et al. (2014) and Ngaba et al. (2019), thus soils on worldwide scale are playing a major role in carbon sequestration and soil organic carbon is a key player for soil carbon sequestration. Its role is widely recognized and is acknowledged by UN's Sustainable development goals, together with the international "4 per 1000" initiative, governed by Soil for Food Security and Climate. It has been launched by the French Ministry of Agriculture at the United Nations Framework Convention for Climate Change: Conference of the Parties (UNFCCC COP 21) in Paris. The main aim, as showed by its title, is to increase worldwide soil organic carbon stocks by 0.4% each year. There is a number of scientific studies, published in the last decade, acknowledging the importance of soil organic carbon for overall carbon sequestration. The current investigation does not aim at deciphering, which are the most influential of them, however, the significance of these papers is an indisputable fact. They include the studies

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of Olson (2014) who attempted to define the meaning of soil carbon sequestration, Sommer & Bossio (2014), Hoyle et al. (2016) who investigated agricultural territories in Australia, Wiesmeier et al. (2016) who also studied croplands, but in Germany. Zhang et al. (2017), Ma et al. (2018) and Lei et al. (2019) conducted experiments at Chinese territory. Mureva et al. (2018) collected soil samples from South Africa, the study of Ghimire et al. (2019) was performed in Oregon, USA and Iizumi, & Wagai (2019) focused on the investigation of droughts. Last, but not least, Sugihara et al. (2019) did field experiments in Cameroon.
Investigations, based on carbon and its association with soil, are not a new topic in Bulgarian science, as well. Almost a decade ago Rodeghiero et al. (2011) included four sampling sites from Bulgaria in their study about ecosystems in the Mediterranean. Then in 2014 Tsolova et al. conducted a study of the carbon stocks in Technosols. Dimitrova et al. (2015) studied carbon storages in Yundola, Georgi Damyanovo and Berkovski Balkan. Nedkov et al. (2016, 2017) also conducted research on carbon stocks and finally, Zhiyanski and coauthors (2015, 2016 a,b, 2020) investigated the carbon pool in Western Rhodopes, Beklemeto and other key areas in the country.

2. Materials and Methods

The study area - Godech Municipality is located in the western part of Bulgaria and covers a territory of around 374 square kilometers (Fig. 1). It is a part of Sofia Province and consists of one town – Godech and 19 other villages. The main town is located in the valley of Nishava River and is landlocked between the mountains of Vidlich, Ponor and Chepan. Berkovska Mountain to the northwest and Vuchibaba are other mountains in the municipality. The climate is temperate continental. Other rivers, apart from Nishava River, are Visochitsa, Shumska and Zabardska – the last two are tributaries of Nishava River.

Figure 1. Location of Godech Municipality.

A cornerstone of the current investigation is the study of Hengl et al. (2017) who created global soil grids at 250 m resolution that are available for downloaded at https://soilgrids.org/. The main author, Tomislav Hengel is working at a non-profit organization, named International Soil Reference Information Center (ISRIC), mainly funded by the Dutch government. ISRIC developed a Global Soil Information system entitled "SoilGrids". "SoilGrids" are created to generate predictions on a global scale about several soil properties, including organic carbon and the current paper uses its latest version (a previous version deals with a resolution of 1 km). For the purposes of the current study, seven datasets were downloaded, containing information about soil organic carbon content (fine earth fraction) in g per kg. These datasets consist of information about carbon contents at the following depths: 0 cm, 5 cm, 15 cm, 30 cm, 60 cm, 100 cm and 200 cm. This data was processed and analyzed for the purposes of the current investigation and the comparative method is applied in order to get better results.

3. Results and Discussion

The outcomes of the study are presented in the following lines. As for soil organic carbon stocks at 0 cm depth (Fig. 2 (left)), it can be argued that data is showing increase of the values from south to north. The highest values can be observed in Berkovska Mountain, located in the northwestern corner of Godech Municipality, and soil organic carbon storages at the area are reaching 264 g per kg. Another territory with almost such high values is locked between the villages of Gubesh and Gintsi at the central part of the municipality. The lowest soil organic carbon contents are located to the south and southwest, where they are as low as 28 g per kg near the villages of Stanintsi and Murgash.

Soil organic carbon contents at 5 cm depth (Fig. 2 (right)) are different from those at 0 cm, but they also follow the same pattern of increase of contents from south to north. Yet soil organic carbon stocks at 5 cm are lower than those at 0 cm. Once more, the values are highest in Berkovska Mountain to the northwest where soil organic carbon contents reach 133 g per kg. The lowest values of 26 g per kg can be found to the northwest of the village of Varbnitsa and to the north of the village of Vradlovtsi to the west.

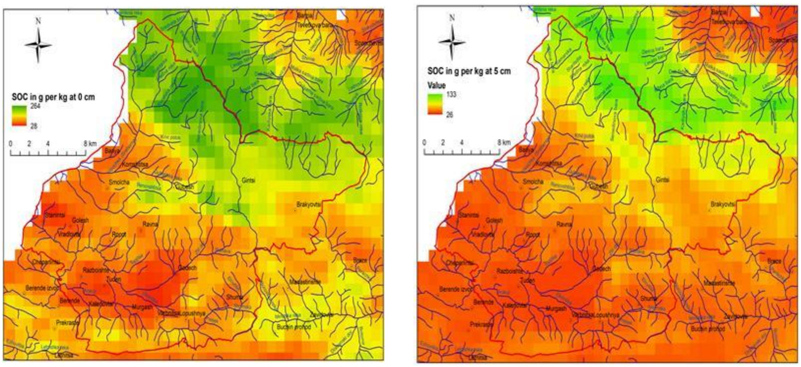

Figure. 2. Soil organic carbon in g per kg at 0 cm (left) and 5 cm depth (right)

The values at 15 cm depth (Fig. 3 (left)) again show the distinctive pattern with a decrease of the stocks from north to south. The highest values once more are at Berkovska Mountain and they are reaching 74 g per kg, while they are as low as 16 g per kg to the north of the villages of Varbnitsa and Murgash.

Data for twice as lower depth – 30 cm display the same pattern (Fig. 3 (right)). The lowest values for soil organic carbon are 9 g per kg and are located mainly to the south and the highest are only 45 g per kg and can be found in the north.

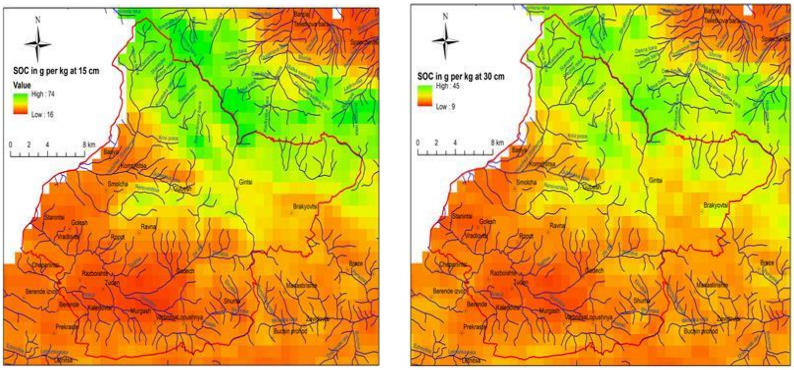

Figure. 3. Soil organic carbon in g per kg at 15 cm (left) and 30 cm depth (right)

The next examined depth is 60 cm and data here again is showing a downward decrease, compared to the previous results (Fig. 4 (top left)). The lowest value is 6 g per kg, while the highest is 30 g per kg, again situated at the same areas.

The last two depths are 100 cm (Fig. 4 (top right)) and 200 cm (Fig. 4 (bottom)). The lowest and highest values are 4 g per kg and 28 g per kg at 1 m and 3 g per kg and 27 g per kg at 2 m. They are following the same geographical pattern with highest values to the north and lowest to the south.

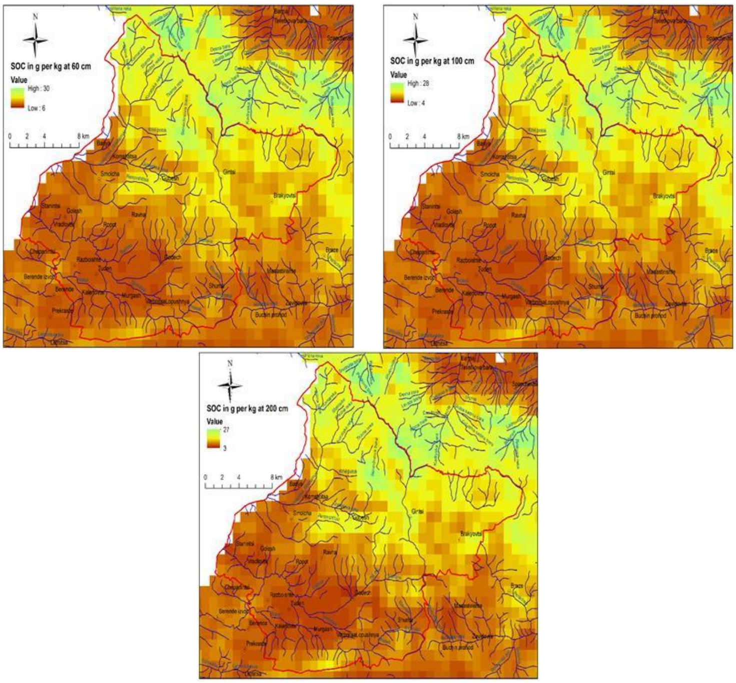

Figure. 4 Soil organic carbon in g per kg at 60 cm (top left), 100 cm depth (top right) 200 cm (bottom).

The outcomes of the study show that soil organic carbon levels in Godech Municipality decrease with depth and from north to south. These lower values in subsoil, compared to topsoil are not the first in scientific literature and this data is consistent with the results of several other investigations. Freibauer et al. (2004) and ten years later Batjes (2014) argue that soil organic carbon stocks decrease with depth. During their study in Ireland, Torres-Sallan et al. (2017) also discuss a decline from topsoil to subsoil. Surely, it has to be clear that the results, concerning soil organic carbon storages in Godech Municipality, are based only on predictions and more data, including terrain sampling, is needed to prove or deny them. This is a weakness of the current research, yet the results are presenting a clear picture that can be applied by policy makers. The authors argue that Godech Municipality has a potential to increase its soil organic carbon pool if proper measures are adopted, including the application of no-till farming and the addition of biochar amendments. More should be done for the investigation of subsoil carbon levels, despite the fact that such focus has been a little neglected, as more experiments are aimed at topsoil. The fact that subsoil has a larger mass, thus storing more soil organic carbon, compared to topsoil, should be taken into account and Godech Municipality does not show different prospects.

Conclusions

The aim of the current study, focused at gathering and analyzing data about soil organic carbon contents in Godech Municipality, was accomplished. A strength of the work is the presence of enough data, allowing for making assumptions and there is sufficient information for seven different soil depths. The results show that soil organic carbon levels increase from south to north and from subsoil to topsoil, which is backed up by several other investigations worldwide. The highest soil organic carbon storages are at 0 cm, reaching up to 264 g per kg in Berkovska Mountain to the northwest. Oppositely, their lowest levels are within 200 cm depth with 3 g per kg, located to the south near the villages of Varbnitsa and Murgash. A weak point of the investigation is the lack of soil probes, which will provide more information about soil's carbon pool, so efforts should be aimed at acquiring such samples. Despite that more have to be done in order to improve the current investigation, it provides sufficient data for policy makers. The successful results may be applied as a basis for widening of the geographic range of the study in the neighboring municipalities, which will present a broader picture for soil organic carbon contents in Western Bulgaria.

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