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UNLOCKING SOIL HEALTH: CARBON DETERMINATION IN AGRICULTURAL SOILS

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GENERAL INTRODUCTION: By accurately measuring organic carbon, the method helps farmers and soil scientists understand soil health, fertility, and the carbon sequestration potential of the soil. It is an essential tool in developing sustainable agricultural practices, such as managing organic amendments and crop rotations, to improve soil quality and mitigate soil degradation.

The cost-effective **Black-Walkley method** is a widely used and effective technique for determining **organic carbon** in agricultural soils. While it mainly targets organic carbon, it provides critical insights into soil health, helping distinguish the biological contributions of carbon. When used in conjunction with other mineralogical techniques, it can help identify the role of lithogenic (inorganic) carbon sources and further enhance soil health assessments.

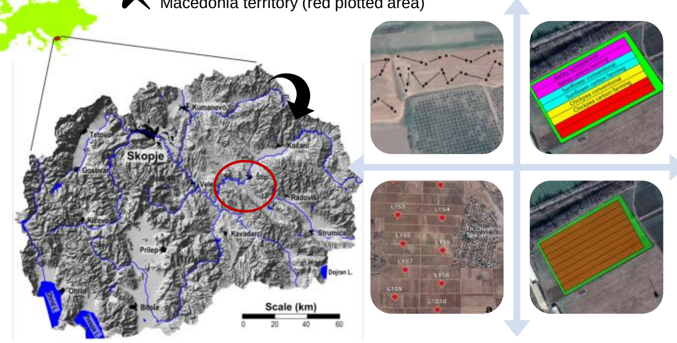
The method helps to isolate and focus on **organic carbon,** but when combined with **mineralogical** analyses (such as clay content or other geological markers), it can contribute to a clearer understanding of how much of the soil's carbon comes from biological processes and how much is influenced by the underlying lithogenic or mineral sources.

If the soil contains a significant amount of **lithogenic** minerals, such as carbonates from parent rock, these can impact the overall carbon content. However, the Black-Walkley method primarily targets the organic fraction, and the effect of lithogenic sources would need to be accounted for separately in some cases. This method helps quantify the **organic carbon** in the soil, which is a key indicator of **soil fertility** and microbial activity. Organic carbon is a critical component for improving soil structure, water retention, and nutrient availability, all of which affect soil health. The Black-Walkley method does not directly measure **lithogenic carbon** (inorganic carbon from parent rock), but it is useful for estimating the **organic fraction** of carbon in the soil, which is influenced by both biological processes and geological sources.

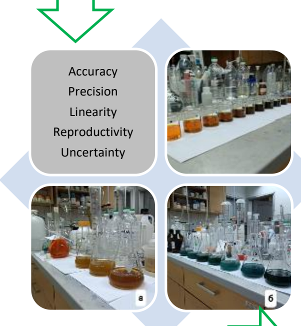
- **Accurate and cost-effective soil carbon analysis** is crucial for sustainable agricultural management, climate change mitigation, and environmental monitoring.
- **SOC (soil organic carbon)** is a key indicator of soil fertility, water retention, and structure, influencing crop productivity and ecosystem services.

METHODOLOGY: Soil samples were collected from the **Ovce Pole region, (eastern part of the territory of North Macedonia), including the landfill with the carbon farming practice (pilot site) as well.** The method validation was improved with QA protocol in accordance with the ISO/IEC 17025:2017. Accuracy, precision, LOD, LOQ, reproductivity, reputability, measurement uncertainty and working range were included for the quality insurance of the method. The data normalization has been introduced using log-normal transformation, for excluding the outliers. Data matrix has been improved with bivariate statistics of correlation matrix and multivariate extraction of dominant variables.

Sampling area location within the N. Macedonia territory (red plotted area)

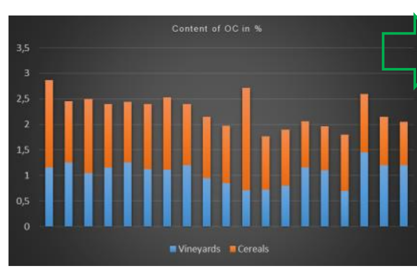


WALKLEY-BLACK METHOD is based on dichromate oxidation, is a standard chemical analysis technique, but its implementation cost can be significant depending on various factors. This study aims to develop a predictive cost model to estimate expenses associated with using this method, considering reagent consumption, labor, equipment, and waste management. It is a wet combustion method involving the oxidation of organic matter using potassium dichromate ($K_2Cr_2O_7$) in a sulfuric acid (H_2SO_4) medium.



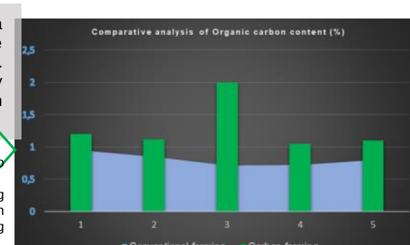
SOIL TYPE	RECOVERY RATE	CORRECTION FACTOR	KEY NOTES
Forest Soils	~63%	1.58	Higher correction factor due to low recovery
Volcanic Soils volcanic rocks, such as andesite's, tuffs, and pyroclastic	70–82%	1.26–1.47	Suitable for acidic soils
Soils on with dominant occurrence in Neogene and Quaternary sedimentary formations	35–45%	2.38–3.34	Significant underestimation in SOC content
Agricultural Soils	70–82%	1.22–1.43	Standard recovery rates

Despite varying recovery rates, the WB method exhibits a strong linear correlation with the DC method, suggesting that the WB method can still provide reliable estimates of SOC when appropriate correction factors are applied.



In general, vineyards have a higher potential for storing organic carbon, especially when managed with cover crops, minimal tillage, and organic inputs. Cereal cropping systems tend to have lower SOC, especially under intensive tillage and without residue management.

However, initial research data showed that in the Ovchepolje region this tendency is reversed. That is, cereals showed a slightly higher tendency for soil carbon retention.



Carbon farming has the potential to increase soil organic carbon content.
A comparative analysis of cereals during initial one-year trials reveals differences in carbon content under carbon farming practices.

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Carbonica

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