1st Serbian International Conference on Applied Artificial Intelligence (SICAAI)
Kragujevac, Serbia, May 19-20, 2022

REMOTE SENSING FOR SOIL ORGANIC CARBON

Marko Pavlović[1,2], Nenad Antonić[2], Gavrilo Bosakov[2], Slobodan Ilić[1], Dubravko Ćulibrk[1,2]

[1] Institute for Artificial Intelligence RD. Fruškogorska 1, Novi Sad, Serbia
[2] Cinteraction, Nikolajevska 2, Novi Sad, Serbia
e-mail: office@ivi.ac.rs, office@cinteraction.com

Abstract:

Global warming represents one of the great worldwide challenges of the 21st century with serious repercussions to the environment and human health [1]. The main cause behind global warming is the rise of the concentration of greenhouse gases (GHGs) in the atmosphere [2].

Emission of GHGs such as carbon di-oxide (CO2), methane (CH4) and nitrousoxide (N2O) is a main factor of global warming. 76% of total GHGs emissions are accredited to CO2, 16% to CH4 and 6.2% N2O [2]. The mitigation of the negative effects of GHGs emissions is a fundamental task of environmental preservation, and the increase in CO2 concentration is as major priority, due to its major share in total GHG emissions.

Previous studies showed that soil plays an essential part in the carbon cycle, functioning as a storage for carbon [3]. Through the process of organic carbon sequestration, around three times more carbon is stored in the soil, than the atmosphere [4].

Currently, the methods dominantly used for monitoring the soil organic carbon (SOC) levels are ground-based techniques characterized by high costs of implementation, time–consumptive, labour–intense activities and limitations in the ability to access difficult terrain and cover large areas of interest [5].

Keywords: remote sensing; soil organic carbon; deep learning; monitoring

1. Introduction

Through the development of technology, new approaches are made possible. One of the promising modern methods is the use of remote sensing (RS), which brings reduction in resource demanding on-site studies, and the ability of covering vast areas of interest through use of satellites, air craft and unmanned aerial vehicles [6].

Furthermore, launching of numerous satellites specialised in gathering Earth observation data (such as Sentinel, Landsat, MODIS, RapidEye, Geofen-1, Geofen-2, HJ-1A etc.) and the set up of plentiful open data services (Copernicus Open Access Hub, Landsat Explorer, OpenAerialMap, NEON etc.) provides a potent mixture of prerequisites to stimulate the development of new solutions.

Smart Cloud Farming (SCF), represents an AgTech start-up specialising in development of advanced analytics solutions, in order to support agricultural stakeholders to measure, monitor, and visualize soil and agricultural production at scale.

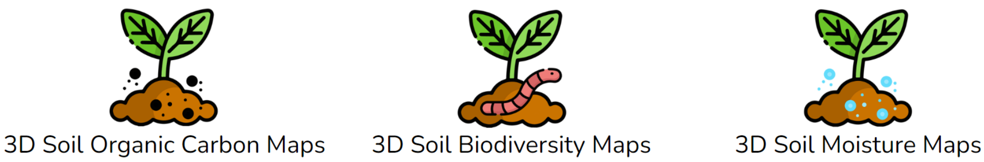

Fig. 1 SCF tools.

In the study presented here, the Soil Analytics Platform developed by SCF is deployed. Platform is based on a combination of a traditional machine learning (ML) and deep learning (DL) models, specifically designed for the prediction of the content of organic carbon in the various types of soil on different continents.

The solution allows continuous monitoring of the levels of SOC in specified plots and the prediction of SOC levels in new plots. Also, it is able to assess the efficiency of using various crops on a particular soil type, as a system for the sequestration of CO2.

This is achieved by collecting and processing satellite images acquired through the RS open access Earth observation mission (Sentinel) and the combined use of DL models with traditional ML algorithms, as shown in Figure 2.

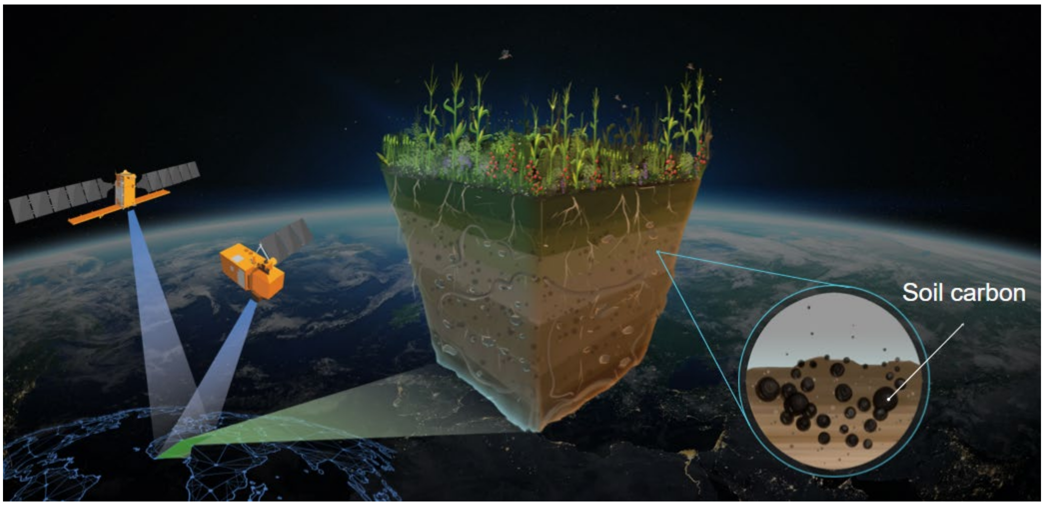

Fig. 2 Data collection.

Our results validate the applicability of the Soil Analytics Platform as a RS tool to support carbon sequestration efforts that is superior to conventional SOC estimation techniques, in terms of cost-effectiveness, time–consumption and resources used and is just as reliable.

References

[1] H. Schellnhuber, W. Cramer, N. Nakicenovic, T. Wigley, and G. Yohe, Avoiding dangerous climate change cambridge university press, 2006.

[2] A. Mandal, A. Majumder, S. Dhaliwal, et al., "Impact of agricultural management practices on soil carbon sequestration and its monitoring through simulation models and remote sensing techniques: A review," Critical Reviews in Environmental Science and Technology, vol. 52, no. 1, pp. 1–49, 2022.

[3] S. Quideau, R. Graham, O. Chadwick, and H. Wood, "Organic carbon sequestration under chaparral and pine after four decades of soil development," Geoderma, vol. 83, no. 3-4, pp. 227–242, 1998.

[4] J. P. Scharlemann, E. V. Tanner, R. Hiederer, and V. Kapos, "Global soil carbon: Understanding and managing the largest terrestrial carbon pool," Carbon Management, vol. 5, no. 1, pp. 81–91, 2014.

[5] T. Kattenborn, J. Leitloff, F. Schiefer, and S. Hinz, "Review on convolutional neural networks (cnn) in vegetation remote sensing," ISPRS Journal of Photogrammetry and Remote Sensing, vol. 173, pp. 24–49, 2021.