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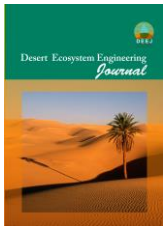

Assessing Soil Carbon Sequestration in Rainfed Vineyards and Diverse Land Uses in Sepidan County, Fars Province

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Introductio: According to annual reports from the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC), greenhouse gases—especially carbon dioxide—are the primary drivers of global warming and climate change. Effectively mitigating these changes requires practical and efficient strategies for reducing atmospheric carbon. One of the most promising approaches is carbon sequestration in soil and plant biomass. Soil, in particular, serves as a massive carbon reservoir, holding more carbon than the atmosphere and all terrestrial vegetation combined. The capacity of both soil and vegetation to store carbon largely depends on land use types and the associated management practices for water, soil, agriculture, and natural ecosystems. Therefore, a comprehensive evaluation of carbon sequestration across various land use systems is crucial for developing and improving carbon management strategies. This study aims to assess soil carbon sequestration in rainfed grape vineyards within Sepidan County, Fars Province. We'll compare its potential against other prevalent land use types in the region. Ultimately, this research seeks to enhance the accuracy of satellite-based estimates of soil carbon, providing more precise data for regional carbon management.

Materials and Methods: We conducted field surveys to pinpoint the precise spatial distribution of rainfed vineyards within the study area. From these vineyards, we collected a total of 50 soil samples. To ensure a comprehensive comparison, we also collected 50 soil samples from each of the other identified land use categories, covering both agricultural and natural land types. All soil sampling took place in 2021 (corresponding to the Iranian calendar year 1400). After collection, we analyzed various chemical and physical properties of the soil. We also generated topographic maps, including data on slope, aspect, and elevation, to account for environmental influences. We determined soil organic carbon (SOC) content using the combustion (furnace) method, a standard and reliable laboratory technique. Finally, we processed and visualized the spatial data on soil carbon sequestration by creating thematic maps derived from the SoilGrids database and the Google Earth Engine (GEE) platform.

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Results and Discussion: Given that a significant portion of Iran lies within arid and semi-arid regions, understanding soil carbon dynamics in the context of drought is essential. Prior research consistently indicates an increasing frequency and severity of droughts, which have directly intensified carbon loss in soils across Iran. In our study, we observed the following land use distribution within the study area:
Pastures: 144,532 hectares (ha),
Forests: 66,516 ha
Agricultural lands: 64,486 ha
Orchards: 8,550 ha
Vineyards: 3,156 ha
Our results reveal distinct patterns in soil carbon storage across these land use types. Pasture lands demonstrated the highest average soil carbon storage, with an impressive 451.6 tons per hectare (t/ha). This was followed by agricultural soils at 432.6 t/ha, forest soils at 418 t/ha, and finally, vineyards with 319.9 t/ha. These findings critically underscore the profound importance of land management practices in optimizing soil carbon sequestration. The variability in carbon storage across different land uses highlights that specific land management strategies can either enhance or diminish the soil's capacity to act as a carbon sink, especially in drought-prone regions like Iran.

Keywords: Soil organic carbon storage, Soil conservation, Land use, Rainfed vineyards, Sepidan County.