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"Bare soil" detection addressing agricultural production optimization throughout the year: case study in Emilia Romagna using Sentinel-2 images.

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Changes in soil practices and management policies are fundamental in order to satisfy future growing food and energy demand, limiting risks of soil depletion. To this purpose remote sensed data are proving crucial for precision farming and for soil characterization and monitoring. In regions where agronomic rotations are adopted, soils experience unproductive periods between two main crops ("bare soil"), causing nutrient leaching, erosion and acceleration of organic matter consumption. Although the presence of "bare soil" period is evident and well known, there are no studies able to provide a dedicated regional framework to draw attention to this issue.

This study aims at mapping soils cultivated but unproductive during certain times of the year ("bare soil") using satellite images. Once detected, "bare soils" are deeply investigated to define their surface and the time duration of the bare soil status. Thereafter, valorization scenarios for these "bare soil" are proposed considering an optimized mix of energy and cover crops.

The applied methodology includes Sentinel-2, 5-days-return-time optical images, with 20 m ground spatial resolution acquired during 2017. The images were pre-processed using the Satellite Image Automatic Mapper™ (SIAM™) and outputs subsequently processed on the QGIS platform and validated with ground truths provided by the regional agriculture authority.

Of the total Utilised Agricultural Area (UAA), results show that up to 20% is "bare soil" from July to October and about 10% is unproductive from November to April. The size of most plots varies from 0.5-2 ha, however, about 30% of the "bare soil" fields have surface size from 3 to 50 ha, sufficient to justify their agronomic exploitation. In a basic scenario where biomass sorghum is cultivated from July to October, 50% of the bioenergy demand can be met through anaerobic digestion.

This study proposes a digital soil mapping methodology able to answer several questions: if yields can be improved, in what period of the year, in which area, how large are the plots. Therefore, the

potential of "bare soils" for increasing food or energy crops and to store more carbon in soils is highlighted.