Open Source Software for Digital Soil Map – An Exploratory Study

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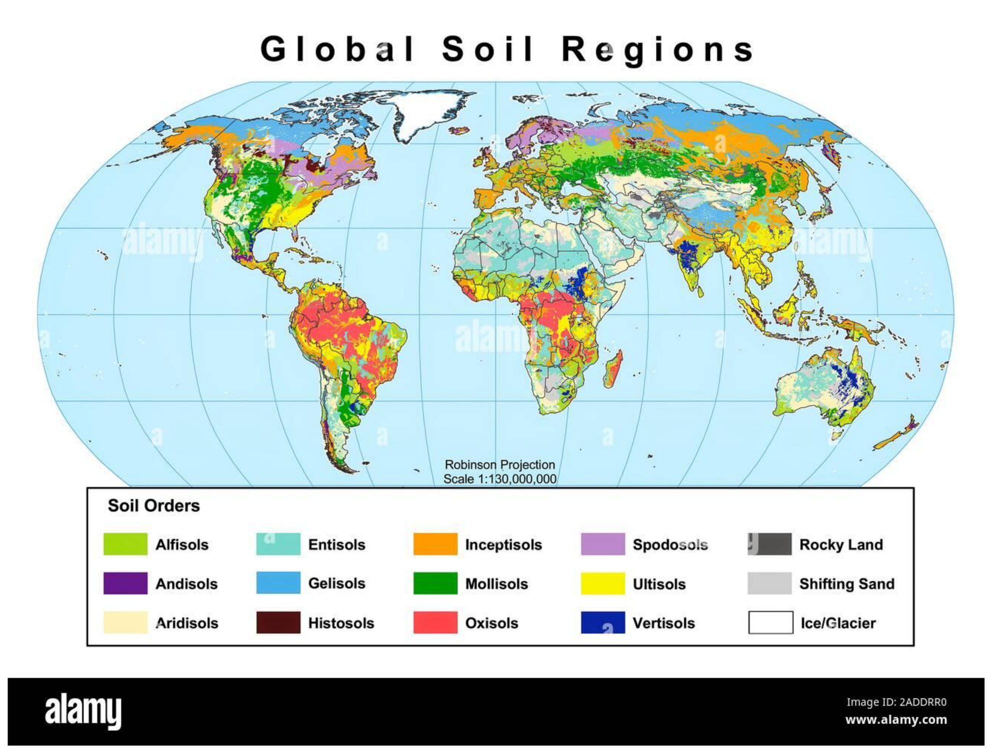
Introduction

1. Digital soil map (DSM) is a spatial soil information system generated by quantitative models using environmental covariates, and seeks to explain soil variations in time and space.

2. Soil attribute = F (soil information, climate, organisms, relief, parent material, age, geographic position, and other spatially connected residuals).

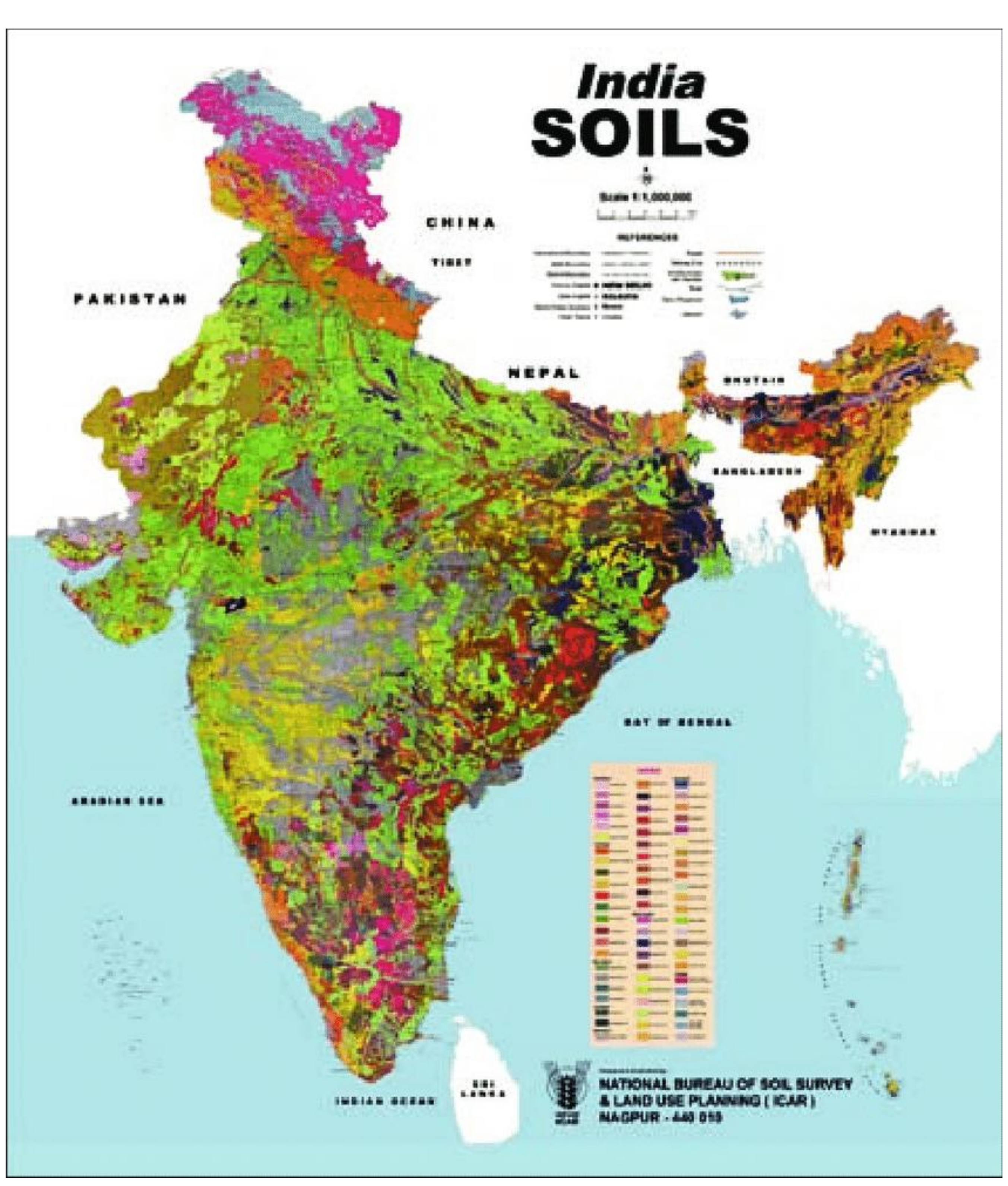
3. The DSM research ideated the requirement of a global grid of soil properties through the GlobalSoilMap project in 2012.

4. The GlobalSoilMap project specifies twelve soil functional properties to describe soil grid:
   i. depth to rock,
   ii. plant effective depth,
   iii. organic carbon,
   iv. pH,
   v. clay,
   vi. silt,
   vii. sand,
   viii. coarse fragments,
   ix. cation-exchange capacity,
   x. bulk density of soil
   xi. Bulk density of earth, and
   xii. water capacity.



Methodology

1. Since computing software is central to DSM, this article examines whether the available open source software solutions can generate comprehensive DSM and achieve the objectives of the GlobalSoilMap.
2. For this purpose, the article attempts to answer the following research questions:
   i. What are the various open source software used to generate DSM artefacts?
   ii. Are these DSM artefacts sufficient to describe the GlobalSoilMap soil functional properties?



Results

The article reports a few open source software solutions:
1. The open source SoilExp software, built using the Python programming language and open source libraries like Tkinter, PySerial, and Matplotlib permits analysis of soil carbon-di-oxide, and measure soil temperature.
2. Another Python-based software, the SALBEC, used soil roughness, day of the year, and other soil properties to predict the variation of sky albedo (unit to measure the capacity of a surface to reflect solar energy).
3. The Smart-Map, available in the open-source QGIS 3.10. used ordinary kriging algorithm to measure the correlation between soil attributes like calcium, magnesium, phosphorous, and potassium and soil covariates like clay, silt, and sand.

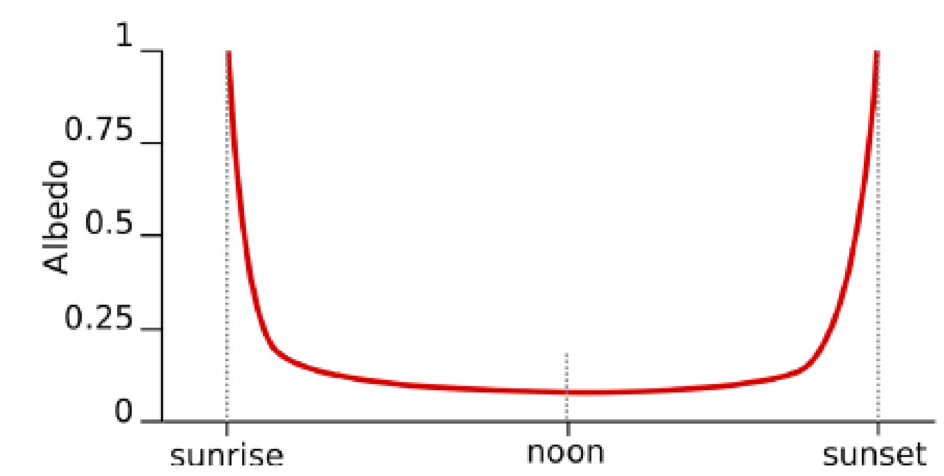


Fig. 1. The general Oren and Nayar (1995) model of the diurnal albedo variation.

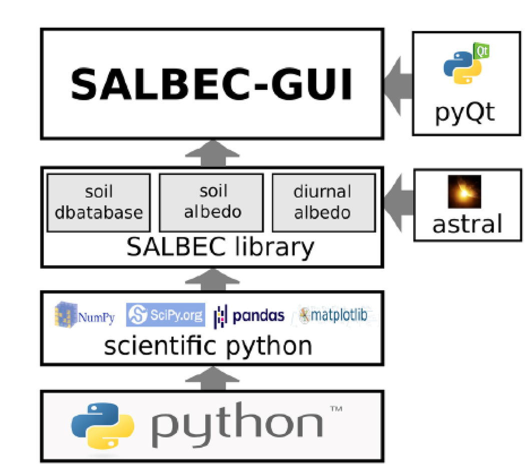
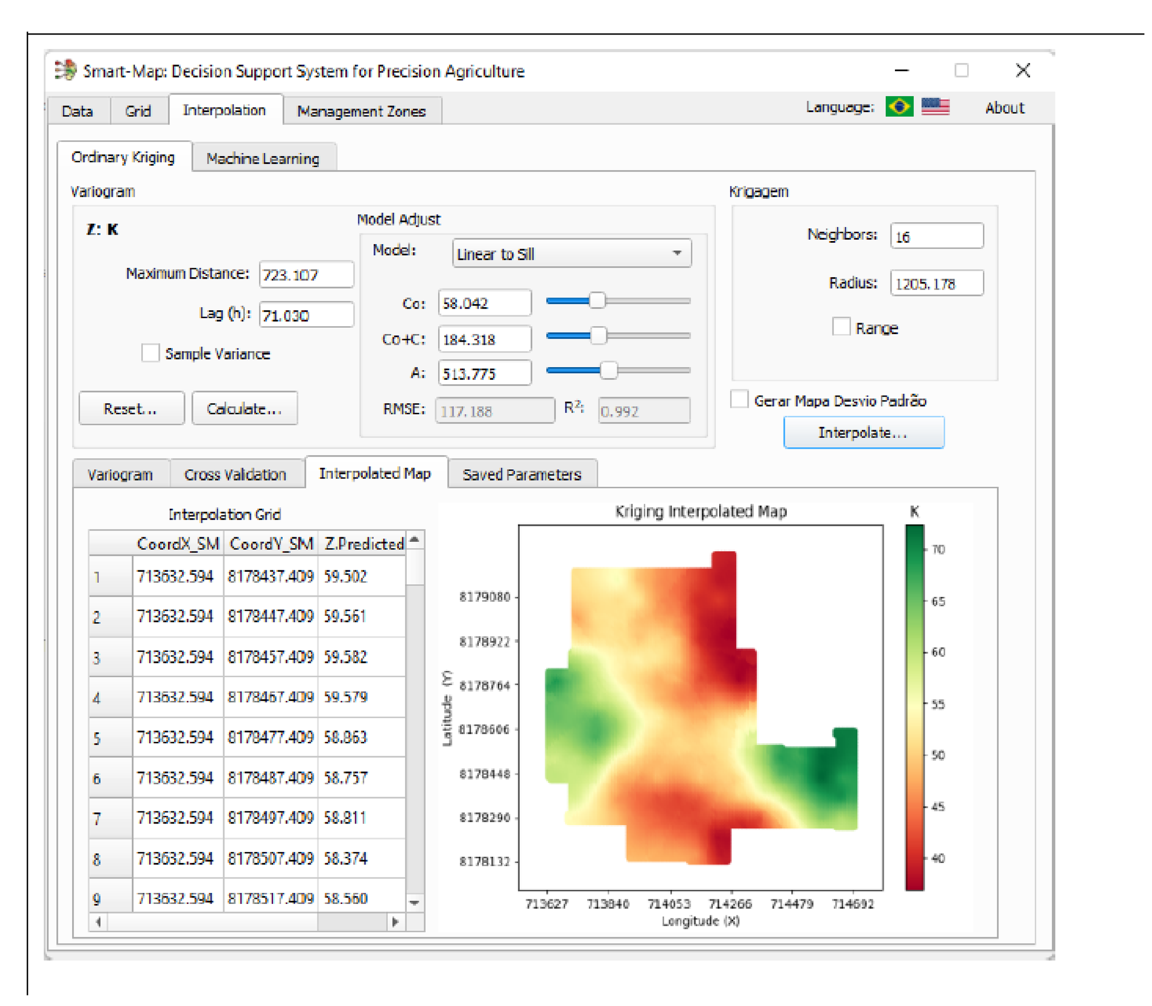


Fig. 4. The architecture of SALBEC software. SALBEC, Soil ALBEdo Calculator.

Conclusion



The existing software solutions are insufficient to map DSM artefacts to the GlobalSoilMap due to the following constraints:
i. non-availability of sampling year information,
ii. intense study focus on soil organic carbon stock,
iii. restricted to the study of top soil less than 30 centimeters,
iv. ignoring soil age,
v. minimal use of pedology, and
vi. insufficient legacy data rescue.

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