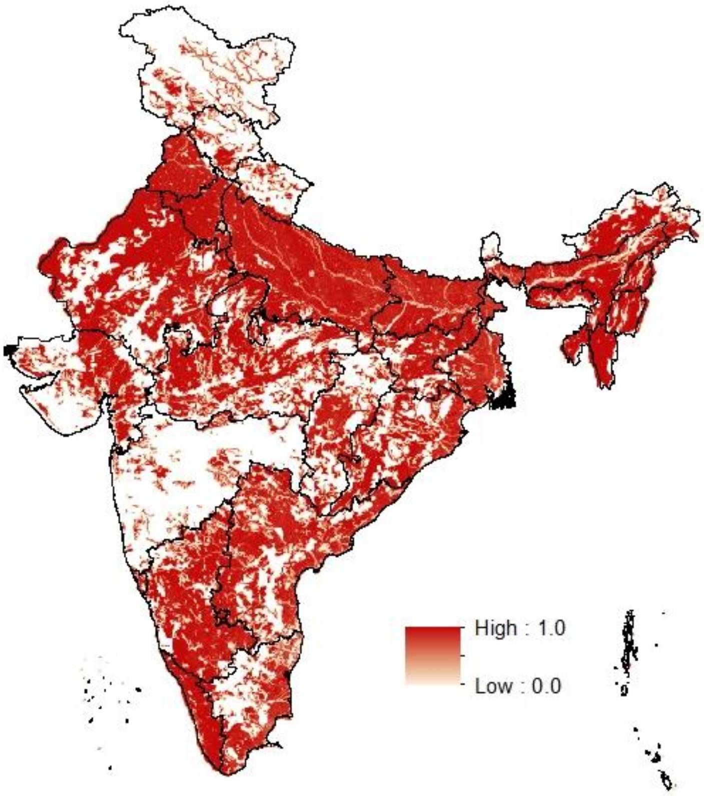
INDIAN SOIL DATA SET

Technical Document



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DOCUMENT CONTROL SHEET

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Title	Indian soil data set
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Abstract	The soil datasets at different scales were integrated using GIS analysis tools like Union and decision rules were applied to generate different soil depth classes and soil texture classes. The grid wise fraction area of each depth and texture class was generated for 5 km X 5 km grid for the entire country using GIS analysis. The data generated under ISRO-GBP project over different soil types, land use, Agro climatic sub regions was used to generate mean soil organic and inorganic carbon densities for the entire country at 5 km X 5 km grid through spatial modeling approach. The 5km resolution products indicating the fraction of extent of soil depth, texture and mean soil carbon density (organic and inorganic) are useful as an input to meso-scale scientific research involving carbon cycle, hydrological cycle, energy budget studies, weather / climate predictions.
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INDIAN SOIL DATA SET

Soil properties are important for their key role in supporting ecosystem services, plant growth, water availability and maintaining carbon stocks. Soil depth is defined as the depth (in cm) to a lithic or paralithic contact (USDA Soil Survey Manual). Soil texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. Texture influences the ease with which soil can be worked, the amount of water and air it holds, and the rate at which water can enter and move through soil. Inventories of soil carbon stocks are needed to assess the possible impacts of global climate change on soil organic, inorganic carbon content in relation to potential green house gas emissions.

Scope of the study

Soil properties derived from soil maps existing at various scales of thematic maps as well as soil profile observations will be used to derive spatial distribution of important soil properties those are required for various regional modeling activities. Currently soil depth class, soil textural class and soil organic and inorganic densities are generated at 5km spatial grids. The properties can form an important input to regional CO_2 emission, carbon balance studies, hydrological and climatological models at regional scale.

Objective

The present study has been taken up with an objective to provide important soil properties at 5 km equal area grid. The representation in this grid cell could be fraction of area occupied in the grid cell for categorical properties like soil depth and textural classes. For numeric properties like soil organic and soil inorganic carbon densities, mean values at the 5km grid cell will be provided.

The soil properties currently being provided are fractional area of various soil depth classes, fractional area of various soil textural classes, mean soil organic density and mean soil inorganic carbon density.

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Data Source

Soil mapping was carried out for sub-regional planning under Integrated Mission for Sustainable Developed (IMSD) and other regional soil mapping projects using multi-temporal satellite data acquired from LISS-II sensors aboard IRS-1A / 1B/ 1C. Soil maps generated at 1:250,000 and 1:50,000 scales under various projects at NRSC carried out during 1985-2005 using visual interpretation of multi-temporal satellite data supported with soil profile studies and soil chemical analytical data were used. For providing soil carbon densities, spatial outputs generated under National soil carbon pools of India - ISRO-Geosphere Biosphere project are used.

Methodology

The soil maps generated under various projects are available in vector format with unique soil mapping code attached to each polygon. A separate attribute table was available describing various soil properties for each polygon. These vector layers were reprojected to Albers equal area projection with following projection parameters.

Projection:	Albers Conical Equal Area projection
Spheroid:	WGS84
Datum:	WGS84
Standard Parallel 1:	28:00:00 N
Standard Parallel 2:	12:00:00 N
Central Meridian:	78:00:00 E
Origin of Latitude:	20:00:00 N
False Easting:	2000000 Meters
False Northing:	2000000 Meters

The attribute table was joined with polygon layer and then they were rasterized to derive property-wise raster outputs.

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Fraction Soil depth and texture class

- The depth attribute present in the attribute table was used to derive each horizon depth. Then the total depth of the profile was calculated and depth class was arrived through logical rule sets. The decision rules were generated on depth attribute to generate different soil depth classes viz. Very shallow (< 25 cm), Shallow (25-50 cm), Moderately shallow (50-75 cm), moderately deep (75-100 cm), Deep (100-150 cm), Very deep (150- 200 cm).
- The mean soil textural class of soil profile has been derived from the taxonomical classification attached to the soil mapping unit. The various soil textural classes of soil profile like sandy (contains 85% or more sand, percentage of silt and 1.5 times percentage of clay shall not exceed 15), loamy (contains 7-27% clay, 28-50 % silt and less than 52 percent sand), clayey (contains 35% or more clay, less than 45% sand and less than 40 % silt) and clayey skeletal (clayey and have 35 percent by volume fragments coarser than 2 mm, with enough fine earth to fill interstices larger than 1 mm) were also generated using GIS analysis tools like Union and by applying decision rules.
- The soil depth/ soil texture pixels which were falling under built-up and water body classes (as generated under Land use / land cover AWiFS project) were erased for generating final soil depth/textural layer.
- The soil depth classes are mutually exclusive and sum of all the depth fractions in a grid cell will not be more than 1.0.
- The fraction area of a depth class under each class is derived as:

Fraction area of a class = Area of a class in grid cell / total area of grid cell

- The grid wise fraction area of each depth and texture class was generated for 5 km X 5 km grid for the entire country using GIS analysis.

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Mean Soil Carbon Density

- To generate maps of soil carbon densities across India, sampling points were identified based on variability in land use, soil, physiography and Agro-ecological Sub regions through identification of unique combinations.
- Random allocation of soil sample points were made in those above unique combinations and depth-wise soil samples were collected up to 100cm or paralithic contact whichever is earlier.
- Insitu bulk density observations were collected from each depth using bulk density rings.
- Coarse fragments of soil samples have been estimated using 2mm sieve as a part of soil sample preparation.
- Soil samples were analysed for organic Carbon, inorganic Carbon, Total Carbon using TOC and CN analyzers.
- Soil organic and inorganic Carbon densities were computed through arithmetic computation using following equation:

$$SCD = (SC * BD * DEP * CF)/10.0 \quad \text{-----} \quad [1]$$

SCD = Soil carbon density (kg m^{-2}) : organic / inorganic
SC = Soil carbon content of soil sample (g/100g) : organic / inorganic
BD = Bulk density (g/ cm^3)
CF = 1.0 - fraction of coarse fragments in soil sample
DEP = Thickness of soil horizon (cm)

- The carbon densities were modeled through Random forests based digital soil mapping approach at 250m spatial resolution using decadal NDVI, land use land cover map, decadal maximum, minimum and mean temperatures,

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precipitation, irrigated area map, rock type, soil sub-order class as independent parameters.

- The predicted carbon densities were validated using field based observations.
- The mean soil organic carbon and soil inorganic carbon densities were arithmetically aggregated as mean density at 5km equal area grid cell using zonal statistics.
- Subsequently, the grid cell polygons were rasterized to obtain Soil carbon density raster output and were exported to ASCII format for distribution.

Outputs

- Fraction area – Soil depth (0-25cm, 25-50cm, 50-75cm, 75-100cm, 100-150cm, 150-200cm)
- Fraction area – Soil texture (sandy, loamy, clay, clayey skeletal)
- Mean total soil organic carbon density
- Mean total soil inorganic carbon density

Sample products generated through this procedure were appended hereunder:

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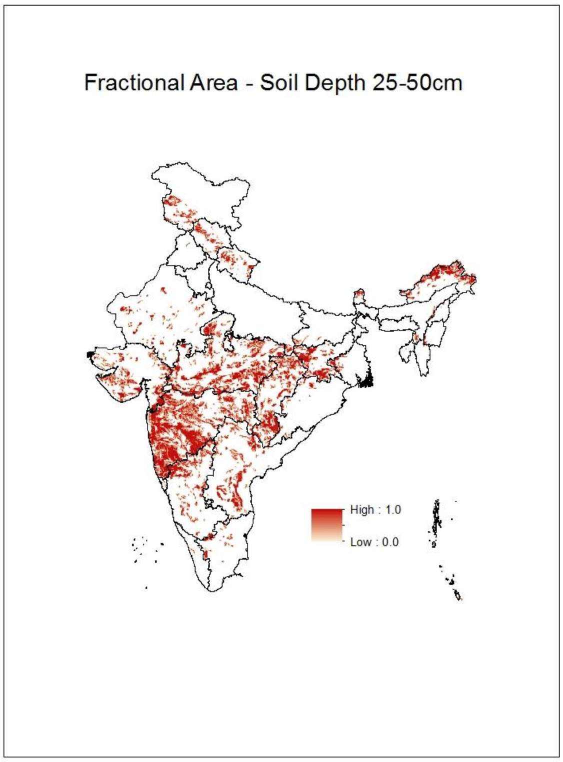
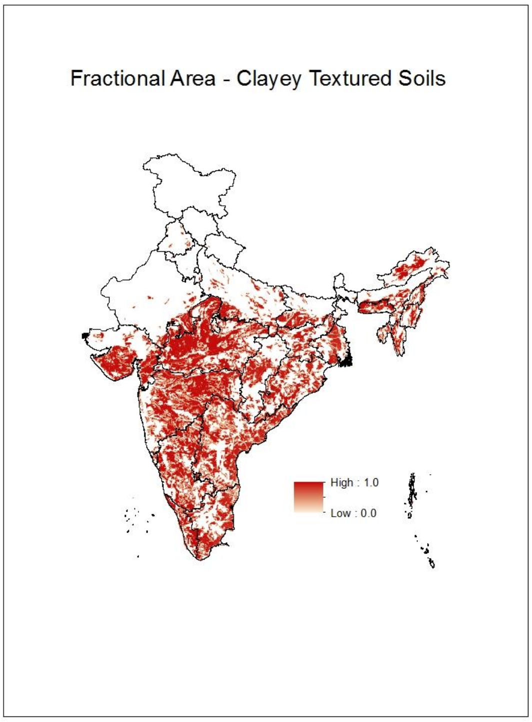
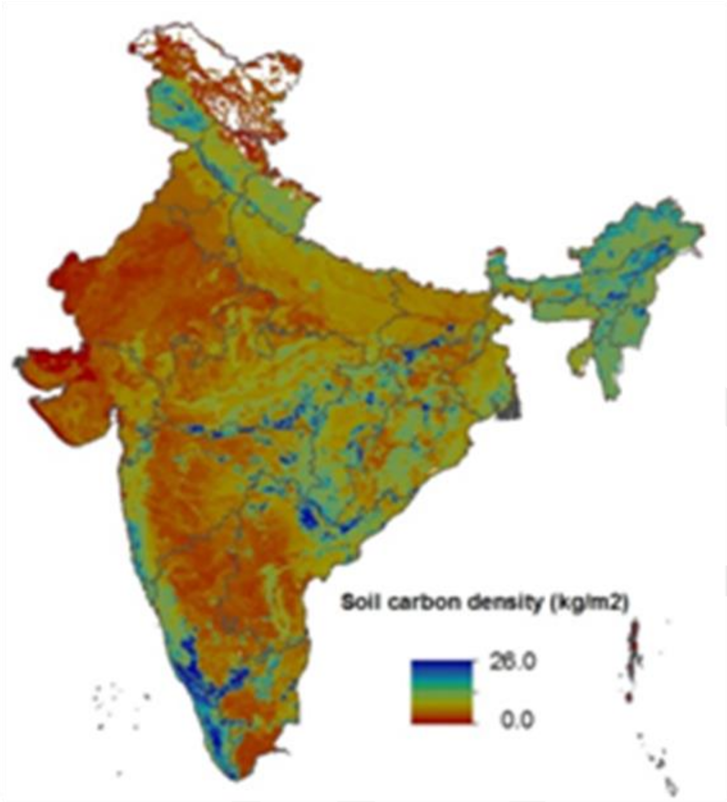

Fractional Area - Soil Depth 25-50cm
High : 1.0
Low : 0.0


Fractional Area - Clayey Textured Soils
High : 1.0
Low : 0.0



Mean – Total Organic Carbon Density

Accuracy:

The current products namely soil depth class and soil textural class are being provided without any numeric accuracy estimate and confidence intervals. The soil carbon density values predicted have a Root Mean Square Error of 1.69 Kg/m^2 and 2.85 Kg/m^2 for Soil organic and inorganic carbon density respectively.

Future Direction:

The available soil profile observations are being arranged in to database. These observations will be used to spatially model the soil properties and will be validated. The digital mapping approach with huge database points should enable to provide better products with accuracy tag.

Publications:

Sreenivas, K., Sujatha, G., Sudhir, K., Kiran, D.V., Fyzee, M.A., Ravisankar, T. and Dadhwal, V.K., (2014). Spatial Assessment of Soil Organic Carbon Density Through Random Forests Based Imputation. *Journal of the Indian Society of Remote Sensing*, *42*(3), pp.577-587.

Sreenivas, K, Dadhwal, V. K, Suresh Kumar, Sri Harsha, G., Tarik Mitran, Sujatha, G., Janaki Rama Suresh, .G, Fyzee, M. A., Ravisankar, T., (2016). Digital Organic and Inorganic carbon mapping of India. *Geoderma*, **269**, 160–173.

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