AGRIBLOSSOM
ISSN-2582-8258
A monthly peer reviewed e-magazine for Agriculture & allied Sciences

DIGITAL SOIL MAPPING - An Important technique

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Introduction

The availability and accessibility of geographic information systems (GIS), global positioning systems (GPS), remotely sensed spectral data, topographic data derived from digital elevation models (DEMs), predictive or inference models, and software for data analysis have greatly advanced the science and art of soil survey. Conventional soil mapping now incorporates point observations in the field that are geo-referenced with GPS and digital elevation models visualized in a GIS. However, the important distinction between digital soil mapping and conventional soil mapping is that digital soil mapping utilizes quantitative inference models to generate predictions of soil classes or soil properties in a geographic database (raster). Models based on data mining, statistical analysis, and machine learning organize vast amounts of geospatial data into meaningful clusters for recognizing spatial patterns.

A significant amount of the data used in digital soil mapping can be archived in a digital format in a GIS, so the expert knowledge used to predict soil distribution on the landscape is retained. Objective sampling plans can be implemented to statistically capture variability of the landscape, represented by digital environmental covariates (environmental data representing soil forming factors). The most exciting aspects of digital soil mapping relate to the ability of depicting smaller segments of the landscape for traditional soil classes, continuous representation of physical and chemical properties in multiple dimensions and the associated generation of raster layers representing respective uncertainties. These are capabilities that will allow soil scientists to more completely and thoroughly represent their soil knowledge to users than the current vector model.

Digital Soil Mapping

Digital soil mapping is the generation of geographically referenced soil databases based on quantitative relationships between spatially explicit environmental data and measurements made in the field and laboratory (McBratney et al., 2003).

Digital soil mapping is the prediction of soil classes or properties from point data using a statistical algorithm. The digital soil map is a raster composed of 2-dimensional cells (pixels) organized into a grid in which each pixel has a specific geographic location and contains soil data. In conventional mapping, the primary question is "Where is the boundary between two soils?" and the focus is on those marginal areas. In digital soil mapping, the central concept is well defined with variation expressed across the landscape.

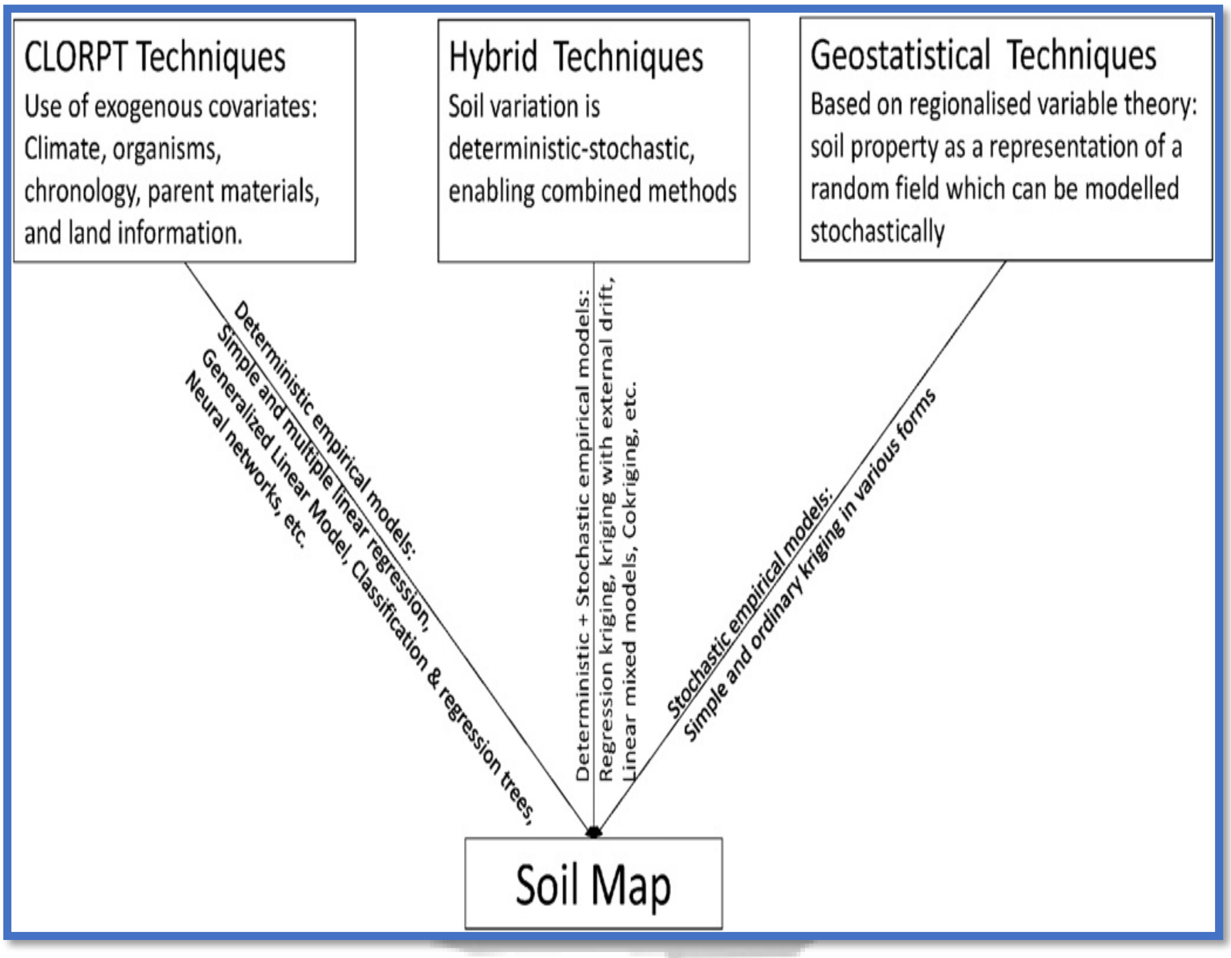
Digital soil mapping (DSM) has become a successful sub-discipline of soil science. The use of computer or numerical models to map soil is not new and researches into methods for creating digital soil maps have been produced since the 1990s. The term digital soil maps has been used since early on, for example Roger Tomlinson, the father of GIS, labelled digitised polygon maps as digital soil maps. A soil map is a graphic representation for transmitting information about the spatial distribution of soil attributes. The earliest soil maps were produced in the mid-18th century for agricultural purposes. These soil maps were made simply to delineate homogeneous areas with intrinsic soil attributes useful in determining suitable land use, and not for soil classification.

The final product is a map with a legend of soil types, which can be difficult to interpret and use. In addition, the subjective nature of the map process yields many drawbacks (Ryan et al., 2000).

However, digital soil mapping is not only about making soil maps using computer or numerical approaches or quantitative relationships between environmental variables and soil properties, according to the definition it needs to have three main components: - The input in the form of field and laboratory observational methods, this includes the use of legacy soil observations or soil maps, and collecting new samples using statistical sampling techniques. The International Soil Science Society (ISSS) Working Group on Soil Information Systems was formed in Wageningen, the Netherlands in 1975 with the aim to develop an information system for soil-related applications. Most of the work in this working group related to soil

databases, data management, storing, retrieving and manipulating data and digitising conventional soil maps reported on computer-assisted soil cartography in France. Computer system approaches were proposed on digitised soil maps.

Soil spatial models where soil properties or soil classes are mapped based on mathematical functions started to appear with the advent of digital elevation models (DEMs) and terrain analysis in the beginning of the 1990s. Geographic positioning systems (GPS) became available, and allowed accurate spatial referencing of field samples and registration with environmental covariates in the GIS because digital soil mapping is dependent on computer power and information technology.



The concept of digital mapping is not only happening in soil science. For example, similar approaches are used in the mapping of species distribution or Species Distribution Modelling (SDM). Digital soil mapping has transformed soil survey and cartography more than anything else in recent times, and it is being tested and routinely used in soil mapping programmes around the world.