

Government Publications Registration Number

11-1390802-000107-01

HARTENUNIK  
2009<sup>th</sup> ESASFS

PROCEEDINGS

# The 9<sup>th</sup> International Conference of The East and Southeast Asia Federation of Soil Science Societies

>> **Soils as a Convergent Technology  
in Tandem with Human and  
Ecosystem Health**

**October 27 (Tue.) ~ 30 (Fri.)**  
**Seoul Olympic Parktel, Seoul, Korea**



East and Southeast Asia Federation of Soil Science Societies  
Rural Development Administration

Korean Society of Soil Science and Fertilizer  
National Academy of Agricultural Science



## GlobalSoilMap.net: Filling in the grid

MacMillan, R. A.<sup>1\*</sup>, Hartemink, A.<sup>1</sup>, McBratney, A.<sup>2</sup>, Hempel, J.<sup>3</sup>, McKenzie, N.<sup>4</sup>,  
Mendonça-Santos, L.<sup>5</sup>, Montanarella, L.<sup>6</sup>, Sanchez, P.<sup>7</sup> and Zhang, G-L.<sup>8</sup>

<sup>1</sup> ISRIC – World Soil Information, 6700 AR Wageningen, the Netherlands, bob.macmillan@wur.nl, (O) +31 (0) 317 471 734; (F) +31 (0) 317 471 700

<sup>2</sup> The University of Sydney, Sydney, Australia

<sup>3</sup> USDA, NRCS, National Soil Survey Center, Lincoln, Nebraska

<sup>4</sup> CSIRO Land & Water, Canberra, Australia

<sup>5</sup> Embrapa, National Center of Soil Research - Embrapa Solos, Rio de Janeiro, Brazil

<sup>6</sup> European Commission - DG JRC, Ispra (VA), Italy

<sup>7</sup> Tropical Soil Biology and Fertility Institute (CIAT-TSBF), Nairobi, Kenya

<sup>8</sup> Institute of Soil Science, Chinese Academy of Sciences, Nanjing, China

### Abstract

The *GlobalSoilMap.net* project is an exciting new initiative with a goal of creating digital maps of soil properties for the entire world at a grid resolution of 90 m. This paper discusses some of the technical details of what needs to be done to move the project from a bold concept towards operational implementation. Five major technical challenges are identified and discussed. These are: a) producing definitive specifications for the output products, b) identifying the most appropriate combinations of input variables and prediction methods to use to make predictions in any given region, c) developing objective criteria for evaluating predictions and methods for applying them, d) developing and implementing a spatial data model and spatial delivery vehicle that is capable of handling massive data sets whose content and definitions will certainly vary over the life of the project and e) collating and processing data for entire continental-scale areas of interest based on a-d above.

**Key words:** Digital soil mapping, GlobalSoilMap.net, predictive mapping, scientific coordination

### Introduction

The *GlobalSoilMap.net* project is organized as a geographically distributed effort with regional nodes having responsibility for planning, organizing, funding and implementing all major project activities (Sanchez et al., 2009). A key challenge is therefore to coordinate the scientific and organizational activities of the different nodes so that the final products produced by the *GlobalSoilMap.net* project are comparable and inter-operable across node boundaries. This paper identifies and discusses some of the key technical challenges that need to be addressed in order to ensure that the project can move quickly and efficiently towards full operational implementation.

### Key Initial Technical Challenges

**Specifications** The first technical priority is for all participants to reach agreement on a clear specification of the products that will be generated by the *GlobalSoilMap.net* project. It has already been agreed that the project will predict values for a specified list of key soil properties by continuous depth function at a 90 m grid resolution. What remains to be defined is what the value reported for any 90 m grid cell represents. Does it represent a value at a single point at the center of the grid, a mean or modal value within the 90 m extent of the grid, or a mean or modal value for some dominant portion of the grid?

**Prediction Methods** Having agreed on what the project will predict; it is important to next achieve some consensus regarding how the predictions will be made. It is critical that each node institute, and complete, one or more pilot projects to apply and evaluate different prediction alternatives that involve use of different sets of covariates and different modeling tools. Consideration about how to make predictions is largely influenced by the quantity and quality of information available about known instances of soil property variation with depth. Are there many or few geo-referenced point observations of soil property variation with depth? Is an area of interest described by soil maps of fine or coarse scale or are there no maps at all? Previous research has shown that it is feasible to make adequate predictions of soil property values by depth given various different combinations of soil map and point data, landscape type and modeling tools. However, each node needs to implement its own pilot projects to identify the specific soil data sets, environmental covariates and modeling methods that best fit the observed soil-landscape patterns in their geographic regions of interest.

**Assessment Criteria** Having completed pilot projects, there is a need for objective criteria for evaluating the success of predictions made by different prediction methods that use different sets of input layers (environmental covariates) and different predictive tools (ANN, decision trees, regression kriging, random forests, fuzzy expert

knowledge). Application of objective criteria to the outputs from regional pilot projects will permit identification of the prediction methods that are most accurate, affordable and timely for use in any given region or node. Basing final decisions and plans on objective criteria is clearly preferable to basing them on personal preferences and expert judgment.

**Spatial Data Model(s)** Concurrent with the completion of pilot projects and development of objective assessment criteria, there is a significant need to design and implement spatial data models and web-based spatial data servers that can effectively store, manage, process and deliver all of the relevant data sets used in, or produced by, the modeling procedures. This is a significant challenge given the vast volumes of data targeted by the project, the inevitability that not all inputs and outputs can be specified precisely from the outset and the need to reconcile and resolve numerous conflicts in meanings, definitions and values reported for similar soil properties in different jurisdictions.

**Operational Mapping** Finally, once we have figured out what we are going to map, how we will map it, how we can evaluate it and how we can store and deliver it, we can then move on to operational mapping. This phase will first require collection and processing of required input data layers for the entire extent of areas of interest. Once the data are prepared, the selected prediction methods can then be applied to those inputs for entire regions. The pilot projects should provide a good estimate of the most likely costs, time lines, personnel requirements, data volumes and assembly issues that can be expected for any given region so that we can plan operational mapping programs accordingly.

### Results and Discussion

Work on implementing the project has begun only recently and so there are few results to present at the moment. It is hoped to be able to present an initial set of specifications for the main output products and to provide a schema for an initial conceptual data model by the time of the ESAFS meetings in Seoul in November 2009. It should also be possible to present some examples of different alternative prediction methods (McBratney et al., 2003) and of an initial proposal for an objective assessment methodology by that time. Fully operational mapping is not likely to begin anywhere until, at the earliest, mid 2010.

### Conclusion

The GlobalSoilMap.net project faces a number of formidable technical challenges. However, like most technical problems, they are resolvable if we begin now and work collectively and diligently. This paper represents a start at identifying and beginning to address the key initial technical challenges.

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