The STEP-AWBH Model
Digital Soil Mapping and Modeling

S. Grunwald
Digital Soil Mapping and Modeling in a Changing World

Challenges: Global climate change, land use change, population growth

Soil Gap  Water Gap  Food Gap

Soil security  Water security  Food security
Conceptual Soil Formation Model

Factorial soil model:
The soil forming factors - climate (CL), organisms (O), relief (R), parent material (P), and time (T) - form soils

Jenny (1941)
SCORPAN Model ➔
Predictions of Soil Properties & Classes

- Quantitative framework suited for digital soil mapping and modeling (DSM)
- Empirical model
- Factors and soil predictions are spatially-explicit (x, y) and temporally-explicit (t)

McBratney et al. (2003). Geoderma
STEP-AWBH Model

Predictions of Soil Properties & Classes

- Enhanced quantitative framework suited for DSM
- Empirical model
- Factors and soil predictions are spatially-explicit (x, y) and temporally-explicit (t)
- Additional factors (W and H)

Thompson et al. (2012). DSM: Interactions w/ and applications for hydopedology.
Key Features of the STEP-AWBH Modeling Concept

- Accounts for time-dependent variation of AWBH variables
- Provides temporal context to account for ecosystem processes and forcings
- Facilitates modeling of soil evolution and change
- Space-time soil model
- Predicts the spatially-explicit evolution and behavior of soil pixels and voxels
- Explicitly incorporates anthropogenic forcings
- Incorporates bio-, topo-, litho-, pedo- and hydrosphere
- Fuses empirical and process-based knowledge

STEP-AWBH Model in a Nutshell

Integration of spatially- and temporally explicit soil forming factors (environmental covariates) into a model to infer on soil properties and their evolution

STEP-AWBH

Target soil property, rate, change, process, risk, etc.

\[ SA(z, p_x, t_c) = f\left\{ \sum_{j}^{n} S_j(z, p_x, t_c), T_j(p_x, t_c), E_j(p_x, t_c), P_j(p_x, t_c) \right\}; \]

Spatially-explicit; account for time-dependent variation of variables

Variable Descriptions of the STEP-AWBH Model

SA: Target soil property, soil class, rate, change, process, risk, etc.
S: Ancillary soil properties
T: Topographic properties
E: Ecological / geographic properties
P: Parent material; geologic properties
A: Atmospheric properties
W: Water properties
B: Biotic properties
H: Human-induced forcings
j: Number of properties from j = 1, 2, …, n
p_x: Pixel (p) with size x (width = length = x) at a specific location on Earth
\( t_c \): Current (c) time (t)
\( t_i \): Time to current \( t_c \) with time steps i = 0, 1, 2, …, m
z: Depth

Application of the STEP-AWBH Modeling Concept to Predict Soil Organic Carbon in Florida, U.S.

Xiong et al. (2014) Env. Model and Software J.
Application of the STEP-AWBH Modeling Concept to Predict Soil Organic Carbon in Florida, U.S.

Fig. 7. Soil organic carbon (SOC) maps at 0–20 cm depth produced by parsimonious models (a) greedy forward random forest model; (b) simulated annealing random forest model; (c) random forest model with all of the 19 continuous all-relevant variables identified by Boruta algorithm. The inset maps in Panel a and b flag the pixels with no predictions due to the inclusion of categorical predictors in the respective prediction models. The inset map of Panel a, for instance, was derived by spatially overlaying the map in Panel a on top of Panel c and the pixels with no predictions in Panel a but with predictions in the map Panel c were flagged. All the GIS layers of predictors were in the same extent and free of missing values, except the ones from the Soil Survey Geographic Database (SSURGO) which had a large data gap in the southern Florida (the gray area).

Xiong et al. (2014) Env. Model and Software J.
References


